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THE SEPTIC-TANK AND FILTER-BED PLAN for treating the sewage of Columbus, O., has been disapproved by the Ohio State Board of Health. The grounds for this action are summarized as follows:

(1) The possibility that open septic tanks for 10,000,000 gallons of sewage will of themselves create a nuisance.
(2) The certainty that septic tanks alone will not prevent pollution of the river in low water, nor remove the nuisance, the chief object for introducing sewage purification works.
(3) The excessive cost of artificial filters that will be required to purify the septic tank effluent, and the uncertainty with regard to the life of such filters.
(4) The lack of exact, scientific knowledge of the septic tank process under varying conditions (i. e., with sewage of different compositions) and the possibility that this process on a large scale may not prove to be of permanent value.

BIDS FOR SEPTIC TANKS AND DOUBLE-CONTACT filter beds at Plainfield, N. J., will be received by the common council of that city on Feb. 18, 1901. There will be two 50 x 100-ft. septic tanks, covered with a wooden roof, and eight filter beds. The walls and floors of both the tanks and beds will be of concrete. The under drains will be of 4-in. horseshoe tile, in 13-in. lengths. The filtering material will be of crushed stone, slag or cinder, or gravel. The lower 6-in. layer, between the drain tiles, will vary "in size from 1½ to 3 ins. in longest diameter, free from all finer material, and washed clean." Above this layer there will be placed 3½ ft. of material of mixed sizes not less than ¼-in. in shortest or more than 1 in. in longest diameter," for the first series, or coarse beds, and ⅛ x ¾-in. for the second series or fine beds, there being four beds in each series. On top of the 4 ft. of filtering material already described the pipes for distributing the effluent from the septic tank will be laid, the sizes ranging from 10 to 3 ins., and the joints to be open. Between and above these pipes 12 ins. more of filtering material will be placed, "of such a size as would pass a 2½-in. ring and be rejected by a ½-in. ring." Mr. Jos. O. Osgood, M. Am. Soc. C. E., of 71 Broadway, New York city, is consulting engineer for this work and Mr. Andrew J. Gavett is city surveyor of Plainfield. The new works, as was stated in our issue of Jan. 10, 1901, are to supersede the intermittent filtration area described in our issue of Sept. 10, 1896.

CONTRACTS FOR SEWERING AND PAVING Havana, Cuba, according to a cablegram sent to this journal by Major General Leonard Wood, Military Governor of Cuba, will be awarded to the lowest responsible bidder, after open competition, and without special privileges to anyone. General Wood states that proposals will be invited formally at an early date and that contractors desiring to bid will do well to begin investigations at Havana at once. We take it that the foregoing announcement means that the right of tanteo claimed by Mr. Michael Dady, of Brooklyn, has been cancelled, an assumption that seems to be borne out by a Havana dispatch stating that the government has arranged to buy all Mr. Dady's rights in law and equity for the sum of $250,000.

THE PROPOSED EXTENSION OF THE HYATT patents on water filtration has been denied by a committee of the House of Representatives.

THE WASTE OF WATER IN ALBANY, N. Y., has been made the subject of a special message by Mr. Jas. H. Blessing, Mayor. He says that with no proportionate increase in business or population, the water consumption in 1900 was 1,525,000 gallons a day more than in 1899, bringing the total consumption up to 18,000,000 gallons a day, or 191 gallons per capita. At this rate of increase, the present filtering and pumping capacity of the waterworks will be reached in a year and to meet the demands another $500,000 expenditure will be required. This means, for interest, sinking fund (one-twentieth the bond issue) and operating expenses, a yearly outlay of about $50,000, or an addition of about 7 cts. to the regular tax rate. Such a direct and business appeal as this should result in united endeavors to curtail waste at Albany, on the part of the common council and the people at large.

BIDS FOR MECHANICAL FILTERS AT LOUISVILLE, Ky., will be received on Feb. 20, instead of Jan. 26, as first announced. The plans proposed were described at length in our issue of Jan. 17, 1901.

BIDS FOR THE FIRST INSTALLMENT OF WATER filter beds at Philadelphia will be received on Feb. 11, under a readvertisement.

DEMURRERS IN THE CHICAGO DRAINAGE CANAL suit have been overruled by the United States Supreme Court and the trial may now proceed on its merits. The action was brought by the State of Missouri against the State of Illinois and the Drainage Trustees, and virtually seeks an injunction against the use of the canal, on the ground that it pollutes the water supply of St. Louis.

A LARGE IRRIGATION CONTRACT IN MONTANA has been awarded by the State Arid Land Commission to Mr. L. D. Beary, of Helena, for $412,000. The price will be paid in bonds, which will be a first mortgage on the 33,000 acres of land in Irrigation District No. 4, which is to be served by the work. The main ditch will be about 50 miles long, ranging from 20 to 8 ft. wide, and having a depth (of water?) of 4 ft. The land is in Lewis and Clarke counties, between the Dearborn and Sun Rivers. Mr. D. A. Cory is secretary of the Arid Land Commission.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred at Warren, Ind., on the Clover Leaf route of the Toledo, Kansas City & St. Louis Ry., on Jan. 23. Two freight trains collided as a result of a misunderstanding of orders. Four trainmen were fatally injured.

A STATE LABORATORY OF HYGIENE for Indiana is proposed in a bill now before the legislature of that state. The same bill also provides for the "sanitary survey of streams, ponds, lakes, factories, mills, works, industrial establishments and cities and towns." The work would be carried out under the direction of the State Board of Health and would include a study of sewage disposal. When means had been found to treat factory refuse in a satisfactory manner the board would be authorized to bring action in the circuit court of the county to compel any factory polluting a stream to adopt the plan laid down. It has been urged against the bill that it is really in the interests of strawboard factories, to give them relief from recent court decisions against them in the matter of stream pollution until something is brought forward in the way of sewage treatment which has been guaranteed by the state authorities.

THE REBUILDING OF THE BUFFALO GARBAGE reduction works seems to have been at a standstill for some time. The works were so badly damaged by fire, a few months ago, that they were shut down. It is said that the Baynes Garbage Crematory Co., which holds the contract for garbage disposal and owned the reduction works, claims that it has been prevented from rebuilding by the tardiness of the State Board of Health in approving its plans.

THE PUMPING PLANT OF THE PAN-AMERICAN Exposition will be located in the Court of the Machinery and Transportation Building. It will consist of twelve pumps manufactured by the P. H. & F. M. Roots Co., of Connersville, Ind., the capacity of which will be 35,000 gallons of water per minute. The twelve pumps will be operated by as many exhibit engines each from a different manufacturer, five of which will be gas engines. The engines will be in service each day from 10 a. m. until 11.15 p. m. They will serve the fountain displays at the electric tower and basin, also in the court of fountains basin, including the fountain of abundance. The intake will be located at the north end of the court of fountains basin, and water will be taken through a 48-in. riveted suction pipe. It will be delivered by the pumps through 16-in. and 20-in. pipes at a pressure of 110 lbs. per sq. in. to the fountain orifices.

BIDS ON SPECIAL FIRE MAINS for Philadelphia were received a few days ago. It is reported that the contract will be awarded to the Hoffman Engineering & Contracting Co. for about $200,000. There was only one other bidder.

MOHAWK RIVER STRAIGHTENING, at Utica, N. Y., is to be undertaken at once, and proposals are invited up to Feb. 21 for this work. This project is in the charge of a commission, of which Mr. Jas. F. Mann is President, and Mr. Stephen E. Babcock is the Chief Engineer. The work is to be done in accordance with Chapter 93 of the Laws of 1891 of the State of New York. This law provides that the Mohawk River is to be straightened at Utica by digging a channel on specified lines; and the cost limit, including land taken, is $150,000. The purpose of the new channel is to protect the city against floods. The estimated total excavation is about 552,000 cu. yds., and there are 374 cu. yds. of rubble masonry to be laid.

THE LICENSING OF ARCHITECTS is proposed in a bill now before the New York Legislature. The object of the promotors of this bill is to guard the profession and the public against incompetency in so-called architects. The bill proposes a State Board of Architects, appointed by the Governor, which shall examine and license architects. While the majority of architects favor its passage, others object to it. The latter say that the bill as drawn would permit certificates to be issued to carpenters, builders and other craftsmen, and would thus tend to lower the tone of the profession proper. It also leaves anyone free to design his own building or to secure architects from other states. Mr. Cass Gilbert says that the present building laws protect the public—if they are properly enforced; and he believes that the standard of fitness can be better regulated within the profession than by legislation.

THE LAKE BAIKAL CROSSING on the Trans-Siberian Railway is giving much trouble; as storms on the lake prevent landing at times, and people are kept on the transfer steamers from 25 to 40 hours at a time. Two lines have been surveyed around the lake, and one of these will be built in the near future. The favored line is by way of Olchy and Toogoontchili, requiring two tunnels, each 1,120 ft. long.

THE HOPPER DREDGE "LA PUISSANTE" has been lately built for use at Port Said on the Suez Canal. This machine will dredge to the depth of 40 ft.; it is built of steel, with 23 watertight bulkheads, is 226 ft. long, 47 ft. beam and 19 ft. draft. The hopper capacity is 2,200 tons of dredged material; and the buckets hold 30 cu. ft. each, and these may be operated at the rate of either 16 or 20 per minute. The contract dredging capacity is 1,150 tons per hour; but it is stated that she dredged 1,600 tons in this time.

THE MOSEL-SAAR CANAL is the latest German scheme for improved inland water communication, says U. S. Consul Hughes, of Coburg. The Mosel rises in France and empties into the Rhine at Coblentz, after following a winding course of 319 miles. At its source the Mosel is 2,411 ft. above sea level, and at its mouth it is 198 ft. above this level. The proposed canal would be about 200 miles long, and overcome a difference in level of 340 ft. by the construction of 42 needle-dams. Including the expense of straightening about 40 miles of the River Saar, the estimated total cost is $18,000,000. The region thus opened up in Lorraine and Saar is an iron and coal center, with cement and brickmaking as important industries.

THE BERLIN INTERNATIONAL EXHIBITION for Fire Prevention and Fire Protection is to be held in June and July, 1901, in commemoration of the 50th anniversary of the organization of the Berlin Fire Brigade. This exhibition is inaugurated for the following purposes: To give the manufacturers of all countries an opportunity to present to the public an exhibit of the present state of the development of the arts and appliances included under this head; and to bring into close contact representatives of the fire brigades of different countries. The exhibits will be divided into six principal groups, as follows: (1) The organization of fire brigades; (2) First aid in emergency cases and danger; (3) Street cleaning and street sprinkling; (4) Fire protection; (5) Beneficiary and benevolent organizations; (6) Subjects of instruction, art and literature. The third group is included because in some German cities street cleaning and sprinkling fall within the duties of the fire department. Under the broad heading of Fire Protection are included: Fireproof building construction, lightning conductors, heating apparatus, chimney sweeping, and all manner of apparatus for fire protection in dwellings, schools, hotels, factories, etc.; theatre protection and fire insurance also form important branches of this section. Prizes, state medals and diplomas will be issued for best exhibits. All further information can be obtained by addressing Mr. Wm. Paul Gerhard, C. E., Corresponding Member of the Executive Committee, 68 Union Square, New York city.

THE EAST RIVER TUNNEL extension of the New York Rapid Transit system was approved by the Commission on Jan. 24. That body decided to extend the Manhattan tunnel from the Post-office to Broadway and State St. under the East River and to Joralemon St., in Brooklyn, with a loop at the City Hall, in Brooklyn. From this City Hall the route would probably be extended underground to the Atlantic Ave. Station of the Long Island R. R. Co. connecting with suburban trains. The estimated cost is $8,000,000. Including $528,000 voted at this meeting, the sum of $1,685,000 has so far been expended for work and materials by the contractor.

A NEW MANUAL INTERLOCKING MACHINE.

Railway interlocking plants at grade crossings and junctions usually have the interlocking effected by means of a number of tappets or dogs engaging with notches in the locking bars which are operated by connections from the levers. An interlocking machine has recently been introduced, however, in which the use of these tappets has been eliminated, the aim being to combine a reduction in the number of moving parts with simplicity and economy of construction, together with low cost of maintenance and sufficient flexibility to allow of the application of the machine under various conditions.

The machine is designed on the usual system of preliminary locking, but with the locking mechanism connected directly to the rockers. The construction is shown by Fig. 1. The lever (A) is pivoted to a shaft carried by the standards of the lever frame. The latch handle (B) is connected by two side bars (C) with the spring latch (D), which engages with the notched ends of the sector guides (E). The tail of the latch extends down through the frame, and carries a link block with a pin (F) working in the slotted rocker link (G) The rocker is hung to pins in the frame, and on its front end is formed the projecting locking piece or tail (H). This lock moves in a vertical slot in the front of the frame and lies across a channel or recess, 3 × 4 ins., which extends the full length of the frame. In this channel are a number of locking bars (J), sliding lengthwise of the frame, and operated by bell cranks connected to the locking tails (H) by connecting rods (K). These bars are of steel, ½ × 4 ins., with rectangular and L-shaped slots, and in any attempt to operate a locked lever, the operator's grip on the latch handle simply exerts a shearing strain upon the bar. Fig. 2 is from a photograph which shows the form of the locking bars. The larger one at the base of the frame is the selector bar.

With this arrangement of locking, there is much less nicety of adjustment required than where dogs or tappets are used, so that wear or irregularity in adjustment do not affect the reliability of the preliminary locking, and the cost of maintenance is correspondingly reduced. Each group of levers governing a route has its own set of locking bars, which extend only in front of those levers which they control, and do not extend the whole length of the frame. The number of levers can be increased as desired, the only change to the original plant being the provision of a new selector or combination locking bar.

The front locking bar (L) is a selector, and in the machine illustrated this is operated by a crank handle (M) and rod (N) carrying a slotted bell crank (O), whose large end is connected to the selector by a stud working in the slot. This machine governs three routes, and the handle has, therefore, three positions, as indicated by the notches on its guide plate. When any one route is to be cleared, the handle is put in its proper position, shifting the selector bar so that its notches are in line with the frame slots of the levers controlling that route, while at all the other slot the solid bar prevents any movement of the rocker locks. With the selector in this position, the onl lever which is entirely unlocked is that of the derail. As this is thrown, however, the downward movement of the locking tail (H) and its connecting rod (K) shifts the locking bars so that their notches release the locking tail of the home signal lever, while L-shaped notches lock the derail lever by holding its locking tail down. When the home signal lever is thrown, it in turn releases the lever of the distant signal. For the reverse locking, the signals must be returned to the "stop" position before the derail can again be opened. The method of operating the selector by a handle is not an essential part of the design, and in one machine now in operation foot levers or treadles have been substituted, while the use of the selector may be dispensed with and electric locking substituted, the locking tails shifting the bars.

One notable feature of the construction is that nearly all the parts are drop forgings, so well and cleanly made as to require a minimum amount of shop work. This ensures economy when once the initial cost for the dies has been made, and also ensures uniformity, so that all similar parts are interchangeable. The lever is a drop forging, as also are the latch handle, spring cap, rocker block, etc. Each sector guide is made of two forgings, with forged distance pieces between the ends, and each rocker link (including its tail) is also a forging. The only shop work on the links is to finish the inside face of the slot and drill the holes for the rod. Conical depressions mark the location of holes to be drilled, and the distance pieces and sectors are made with conical depressions and studs which lock the parts in position when put together, holding them so that only a single rivet is required. The drop-forged metal is very hard and resists wear. All the ground connections, bell cranks, T-cranks, compensators, pipe jaws, etc., are also drop forgings.

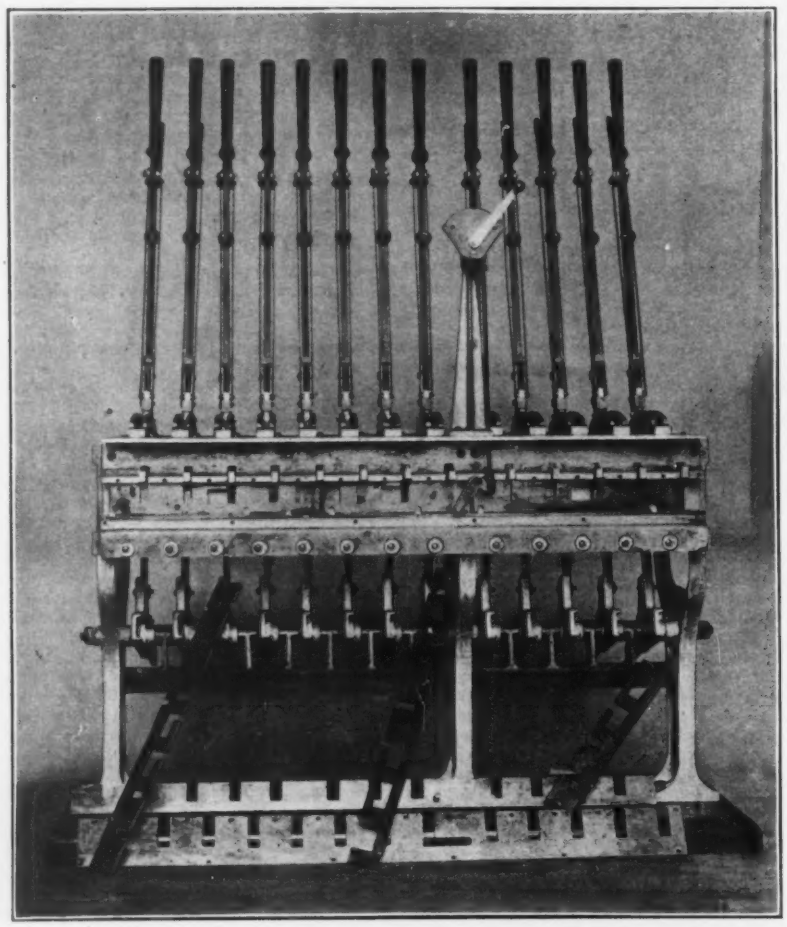


FIG. 2.—VIEW OF MANUAL INTERLOCKING MACHINE, SHOWING LOCKING BARS REMOVED.

This system is the invention of Mr. Benton C. Rowell, of the Rowell-Potter Safety Stop Co., 723 The Temple Building, Chicago, Ill. Two of the machines are now in use; one (with nine levers) is on the Peoria & Pekin Terminal Ry. (Eng. News, Feb. 8, 1900), at Peoria, Ill., where this line crosses the Chicago, Burlington & Quincy R. R. The other machine (with 13 levers, Figs. 1 and 2) is on the Illinois Terminal Ry., at Glassboro, Ill., at the crossing of this road with the Cleveland, Cincinnati, Chicago & St. Louis Ry., and the Chicago & Alton Ry. A plan of this crossing is shown in Fig. 3. On the two latter roads, the tracks are bonded for a distance of about 500 ft. beyond the derails, and the electric locking is so arranged that when a train has once passed this point (or entered the limits of the locking) the signalman cannot open the derail for that route until the train has passed the limits of the electric locking, 500 ft. beyond the derail on the opposite side of the crossing. Mr. J. W. Ewald is Engineer of Maintenance of Way of the Illinois Terminal R. R., and we are indebted to him for particulars of the Glassboro plant.

MUNICIPAL IMPROVEMENTS AT ATLANTA, GA.

Instead of letting contracts for each job of sewer, sidewalk or curb work, the city of Atlanta, Ga., awards separate contracts for the various classes of labor and material at the beginning of each year. It buys sewer pipe, brick, cement and castings. Contracts for excavation are let by the cubic yard, and for pipe-laying by the lineal foot.

With the exception of a limited district, all the sewers of Atlanta are on the combined plan. Most of the sewage is discharged into Peach Tree Creek and South River.

Street cleaning is done by the city. The sweepings are shipped by rail to farmers, who pay a small price for them.

A large amount of night soil is collected by the city. It is taken from houses twice a week, in the buckets into which it falls, and emptied into wooden casks, of 20 gallons capacity each. The casks are provided with cast-iron lids and rubber gaskets, held down by rods extending longitudinally through the center of the casks. The casks are hauled to the garbage furnace, and their contents emptied into storage cylinders, from which the stuff is admitted to the furnace in small doses, alternating with the garbage and light refuse. The casks are washed and disinfected before leaving the furnace. Mr. Geo. M. Hope is Chief Sanitary Inspector of Atlanta.

The garbage is collected by the city and burned in a furnace owned and operated by the Lester Furnace Co.

There are one electric light, one gas, two telephone and two street railway companies. A second electric light company has applied for a franchise. The present, or Georgia Electric Light Co., furnishes current for the Atlanta Rapid Transit Co., the two companies being owned by the same interests.

The two companies just named have under way and nearly completed improvements which they state involve an expenditure of about $1,750,000. We are indebted to Mr. H. M. Atkinson, President and General Manager of the Georgia Electric

Light Co., and also at the head of the Atlanta Rapid Transit Co., for the following outline of these improvements, sent us on Jan. 18, 1901:

UNDERGROUND SYSTEM.—The entire system of wires, serving between 80 and 90% of the business, has been put underground. The conduit system has a reserve capacity of 100%, or in other words twice as many wire ducts have been provided as are actually required at the present time. The conduits are single tile ducts 3 ins. in diameter and 1½ ft. long. They are installed in groups ranging from 2 to 36 ducts to a trench. On Jan. 1, 1901, there were 30,781 ft. of trenches, containing 189,251 ft. of duct and 156,320 ft. of wire.

SUB-STATION.—A valuable piece of property was secured at the exact electrical center of the underground district and in close proximity to the heaviest loads. A complete storage battery plant has been installed in this sub-station and ample space has been provided for increasing its capacity 100%. Over 80% of the current in the underground district will have to be transmitted a distance of less than 1,200 ft. The entire work is nearing completion, though, of course, there will be more or less to do for some months.

THE ATLANTA RAPID TRANSIT CO.—This company is just completing a comprehensive system of street railways. The entire system is new throughout. All lines in the city proper are double-tracked, laid with 88-lb. semi-grooved girder rail. The cars are of the latest and best pattern. All construction throughout is of the most modern and permanent character. Outside the paved districts of the city 70-lb. high T-rail has been used; oak ties have been used throughout. The system is about half in operation, and we expect to put the other half in operation during the present month. The completed system will cover, in round numbers, 35 miles of track, and will operate 45 cars, which have all been ordered, and about one-half of which have already been delivered. The prospects of the company are excellent; the business is growing daily. Messrs. Ford, Bacon & Davis, Singer Building, New York city, have had charge of the engineering part of our work.

Besides the electric light company both telephone companies have all their wires underground in the center of the city.

The Atlanta Standard Telephone Co. used vitrified clay conduits, in sections about 6 ft. long, with four ducts to each. These conduits were made under patents owned by John T. McRoy, 915 Chamber of Commerce, Chicago, and 320 Broadway, New York city. The underground system covers the entire fire district of the city, and reaches a total of 193,533 duct feet. The company also has 99,393 ft. of 120-pair underground cable made by Roebling Sons. Its 30 and 60-pair aerial cable aggregates 73,368 ft. The company has 2,200 subscribers, which it charges $36 a year for business and $24 a year for residence service, inside the city limits. The plant is not fully completed yet. It is being constructed under the supervision of Mr. H. A. Douglas, Manager of the Southern Standard Telephone Construction Co., 104 Edgewood Ave., Atlanta, Ga., who is also managing the local plant for the present.

The Bell Telephone Co., for the larger part of its underground work, used cement pipe, wrapped in sheet iron, the whole embedded in concrete after being placed in the trench.

The Atlanta Railway & Power Co. put a central heating plant in use about Nov. 1, 1900. It utilizes exhaust steam from the engines of its new power station. Up to Dec. 17, only one side of a 2,000-HP. compound engine was in use at the new station, but the other side will be ready soon. A new 2,500-HP. engine is to be erected at once, and an 800-HP. engine will be moved over from the old station. Later on, a plant for lighting service will be installed at this station. The plant is equipped with Babcock & Wilcox boilers and Acme automatic stokers. Ashes will be removed by power at a later date.

The steam pressure on the heat mains is 5 lbs. at the station. At night, or at any other time of light load, live steam from the boilers is admitted automatically to the heat mains through pressure reducers.

The underground system covers the central part of the city, and a small portion of the residence district, about four miles of underground mains having been laid. Connections are now being made with buildings, and on Jan. 1, 1901, about 60,000 sq. ft. of radiation had been connected, the company taking on customers as rapidly as they can put in the service mains. Buildings now piped for steam or hot water do not have to change the piping in any respect.

The steam-heating pipes are of wrought iron. The main pipe is 16 ins. in diameter, covered with 1 in. of sectional covering, surrounded by 4 ins. of dead air space. The side walls of the gallery are of 8 ins. of brick, and its top is covered with two layers of creosoted plank, over which is built a brick arch. The pipe itself is carried on rollers and guides and supported on brick piers. The other sizes of steam pipe are encased in Puget Sound fir and Michigan white pine pipe, having a thickness of shell of 4 ins., and being built with thoroughly kiln-dried creosoted staves. The casing is tin-lined and thoroughly coated with asphalt and pitch on the outside. The expansion and contraction is provided for by means of packingless devices called variators, which are incased in brickwork filled with an insulating material. Thus there are no offsets in the mains to increase friction, and no manholes except at the street corners, where cut-off valves on lateral lines are installed.

The central heating plant was installed by the American District Steam Co., of Lockport, N. Y., which has kindly revised and extended the foregoing description of the same.

Mr. Thos. Elliott is chief engineer of the Atlanta Railway & Power Co.

The city owns its water-works, pumping its supply from the Chattahoochee River, through mechanical filters of the pressure type. The pumps and filters are located some six or seven miles from the city. The chief fault with the water-works is that the distribution system includes an undue proportion of small pipe.

The city has fire and police alarm telegraph. It owns a cemetery, which was the only one in the city until about 15 years ago. It does not own public baths.

Mr. R. M. Clayton has been city engineer of Atlanta since 1879, and Mr. W. T. B. Wilson has been assistant city engineer since 1891. We are indebted to both these gentlemen for information given and courtesies extended to a representative of this journal while on a visit to the city on Dec. 17, 1900.

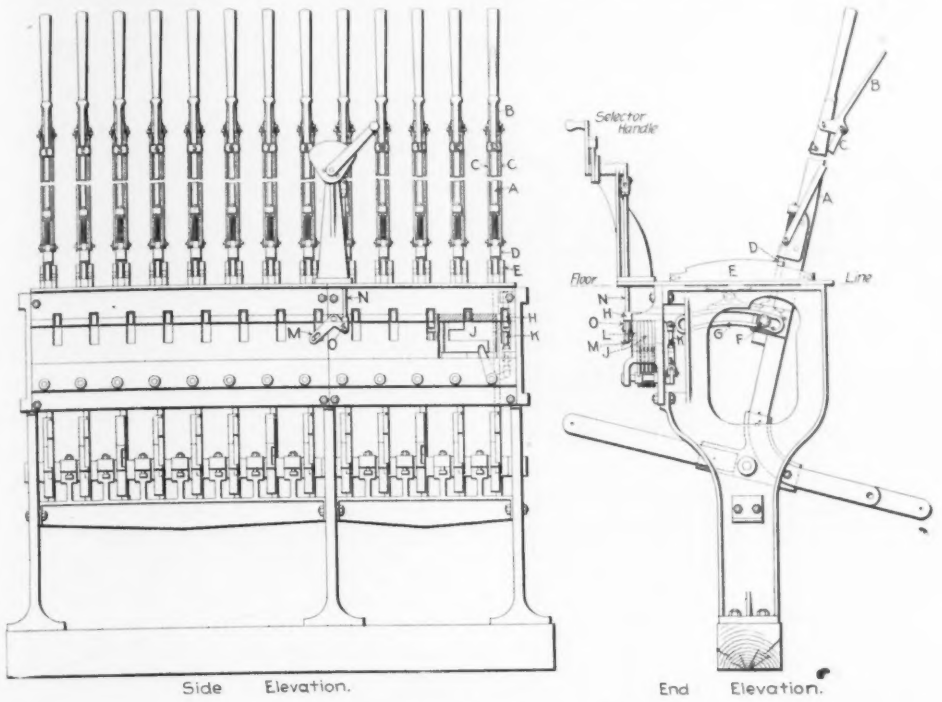


FIG. 1.—MANUAL INTERLOCKING MACHINE.
Rowell-Potter Safety Stop Co., Makers.

BASCULE BRIDGE OVER THE CHICAGO RIVER AT CLYBOURN PLACE, CHICAGO.

(With two-page plate.)

Drawbridges of the bascule type are at the present time somewhat exceptional, being only used, as a rule, under somewhat special conditions. Within the next few years, however, bridges of this type will be somewhat numerous at Chicago, in consequence of the policy adopted by the city authorities for improving the river. Among the most important improvements decided upon for improving the navigation and increasing the flowage capacity to the Drainage Canal, is that of removing the present swing bridges and their pivot piers, and replacing them by bascule bridges, having no center piers to obstruct navigation or flow. The navigable portions of the river are now crossed by 58 drawbridges, of which 8 are for railways exclusively, 48 for streets and street railways exclusively, and two for both street and railway traffic. These two latter carry Lake St. and the Lake St. Elevated Ry.; and Wells St. and the Northwestern Elevated Ry., respectively. Of all these existing drawbridges, 50 are swing bridges (all but one—the C., M. & St. P. Ry.—having center piers); one is a vertical lift bridge (at Halsted St.); two are folding bridges (at Weed St.

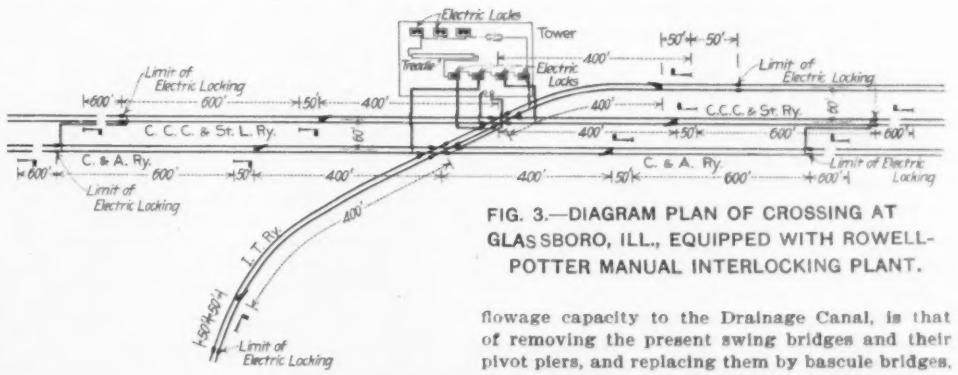
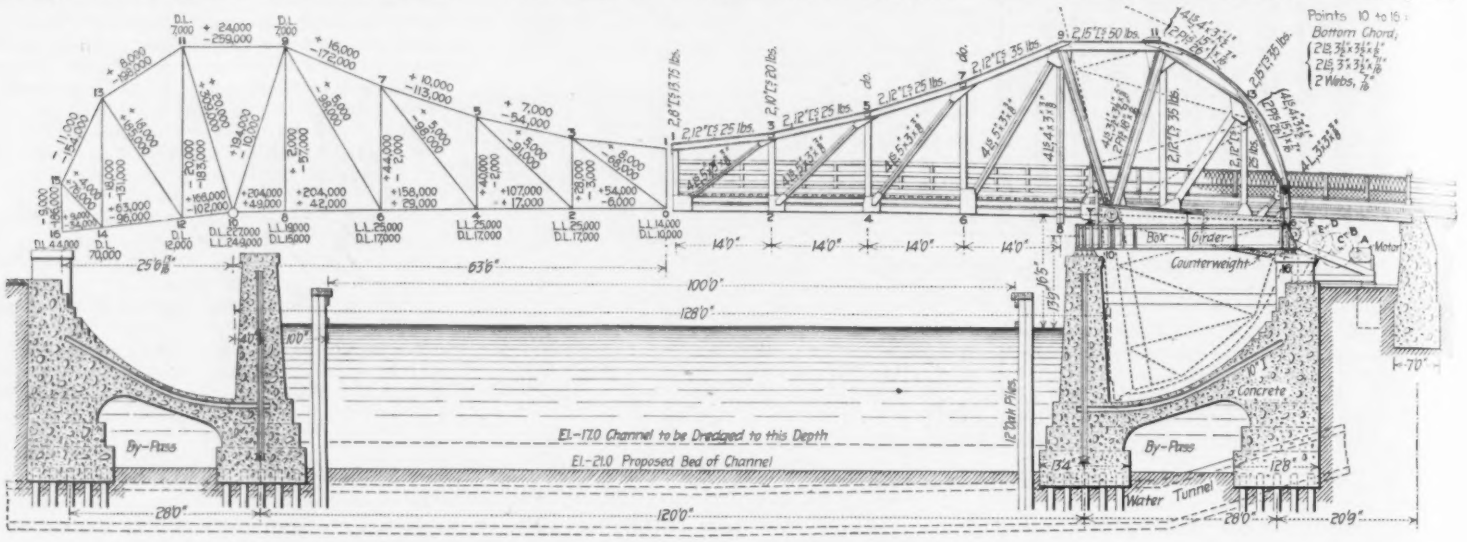


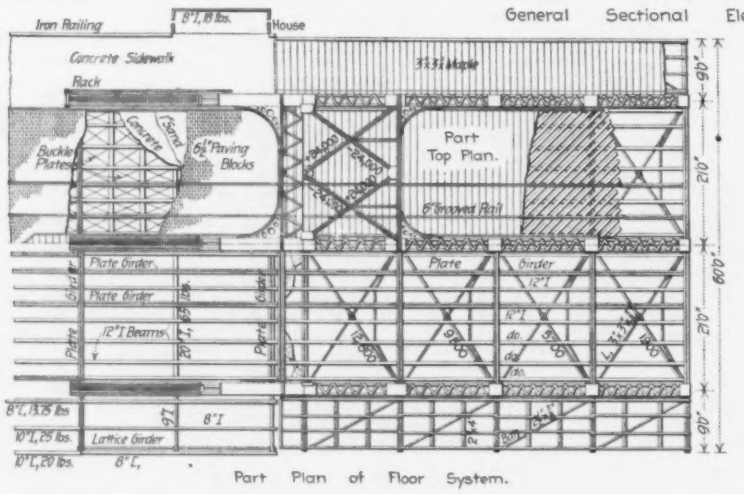
FIG. 3.—DIAGRAM PLAN OF CROSSING AT GLASSBORO, ILL., EQUIPPED WITH ROWELL-POTTER MANUAL INTERLOCKING PLANT.

and Canal St.), and 5 are bascule bridges (Eng. News, March 15, 1900). The present scheme of improvement provides for the replacement of 12 swing bridges with as many bascule bridges.

In the present article we shall describe the bascule bridge to be built at Clybourn Place, and some of the other bridges will be practically identical with this. A general elevation and plan of the bridge are given in Fig. 1. The design was prepared by Mr. Edward Wilmann, City Bridge Engineer, and Mr. John Ericson, City Engineer, with a view to its adoption for all the bridges of this type. It was approved by Mr. L. E. McGann, Commissioner of Public Works, and by a board of consulting engineers appointed by him, composed of Ernest L Cooley, M. W. Soc. C. E.; Ralph Modjeski, M. Am. Soc. C. E., and Byron B. Carter, M. W. Soc. C. E. The details of the design for the Clybourn Place bridge and its machinery have been worked out with great care under the direction of Mr. Wilmann, to whom we are indebted for plans, specifications and other information. Credit is due also to Messrs. Karl L. Lehmann, Alexander von Babo and Thomas Pihlfeldt, structural iron designers; and to Mr. Bley, machine designer, for their work in connection with the design.



General Sectional Elevation.



Part Plan of Floor System.

FIG. 1.—GENERAL ELEVATION AND PLAN OF BASCULE BRIDGE OVER CHICAGO RIVER AT CLYBOURN PLACE.

John Ericson, City Engineer; Edward Wilmann, City Bridge Engineer.

GENERAL DESCRIPTION.

The Clybourn Place bridge will be of the fixed-center, double-leaf bascule type; 128 ft. long, c. to c. of pivot bearings, and 120 ft. c. to c. of piers, with a clear channel width of 100 ft. between the pile protection works. Each leaf will have three through trusses operated by racks on their curved heels, the heels descending into pockets in the abutments when the bridge is open. The clear headway above the normal water level is 16 ft. 6 ins. at the center. The channel will be dredged to a depth of 17 ft., and eventually to a depth of 21 ft. The total width of the structure will be 60 ft., the trusses being 21 ft. c. to c., and the sidewalks being carried by 9-ft. cantilever brackets. The pivot bearings are 4 ft. back from the center lines of the piers, and are carried by box girders spanning the tail pits in the abutments. The approaches are carried by 10-in. and 12-in. I-beams supported by plate girders, resting on the box girders, and extending from the river piers to masonry abutments independent of the abutments of the moving span. The approach roadway is paved with 6½-in. paving blocks on 1 in. of sand, laid on a concrete base upon steel buckle plates (with the convex side upward) between the floor beams. The sidewalks are of concrete. The moving part of the bridge has a wooden floor for both roadways and sidewalks. The bridge turns through a maximum angle of 76° 58′, which requires a travel of 35 ft. on the pitch line of the rock.

SUBSTRUCTURE.

The substructure consists of two main piers and abutments built of Portland cement concrete; and two small abutments of concrete, with walls of rubble masonry extending back from these latter abutments. The substructure construction is shown in Fig. 1. The main piers and abutments are of the steel-concrete type of construction, the pier and abutment on each side of the river being a monolithic concrete mass, reinforced by a steel framework, and connected by the invert and side walls of a pit or pocket to receive the heels of the trusses when the bridge is raised. To provide additional waterway, a by-pass is formed under each tail pit. The piers are 60 ft. long on the coping. These piers and abutments were described and illustrated in detail in our issue of Jan. 17, 1901. The design was prepared by Mr. Wilmann, City Bridge Engineer, in accordance with the recommendations of the Board of Engineers, whose report was given in our issue of Jan. 10.

SUPERSTRUCTURE.

The superstructure consists of two pivoted leaves, each having three through trusses, 21 ft. c. to c. These trusses are 9 ft. deep, c. to c. of chords, at the outer end, and 24 ft. 6 ins. over the pivot pins. The heels are curved to a radius of 26 ft. 4 ins., and carry the operating racks. The top and bottom chords are each composed of two 12-in. steel channels, 13 ins. apart, set with the flanges inward for the bottom chord and outward for the top chord. These are connected by top and bottom lacing bars, ⅜ × 2½ ins. in the lower chord and 7-16 × 2½ ins. in the upper chord. The posts are of a similar type of construction. The diagonals are of H section, built up of four-flange angles, with lacing bars forming the web members. At all panel points large connection plates and gussets are used heavily riveted, in order to ensure ample strength and rigidity to prevent loosening of the rivets and joints under the racking strains to which the structure will be subjected. At panel points Nos. 7 and 9 are portal trusses, with curved knee-brace connections to the posts. The lightest of these, at No. 7, is shown on the detail drawing of the truss. That at No. 9 is somewhat heavier, 3 ft. 3½ ins. deep, while the vertical transverse truss is 6 ft. 7 ins. deep, and has a single intersection of the diagonals, while the knee-braces are smaller. The top lateral bracing consists of diagonal members of H-section extending between panel points Nos. 7 and 9 of adjacent trusses, the ends of the laterals being riveted to large connection plates on the trusses and portals. The bottom laterals are single angles beginning at panel point No. 8, and having struts to support the plate-girder floor beams when the bridge is open. The lower chords of the tail ends of the trusses are not connected except by a Z-bar cross strut at the very end.

Behind the pivot pin, the lower chord of each truss is a heavy plate girder, with two webs and outside flange angles, connected by lacing bars and batten plates. Upon these girders are fitted the counterweight blocks of cast iron, as shown, they being secured by 1½-in. bolts.

The floor beams are plate girders, with webs ⅝ × 28 ins., riveted between the posts. Between these girders are eight lines of stringers to each roadway. These have the tops level with the tops of the floor beams, and are secured by angle iron brackets riveted to the webs of the girders and beams, as shown in Fig. 3. The outer stringers also rest upon angle brackets. Six of the stringers are 12-in. I-beams; the others (one under each rail of the street railway track) are 12-in. plate girders. The end floor beam nearest the pivot is set lower than the others, and the stringers rest upon the top chord. Laid across the floor

beams and stringers at an angle of about 45°, are yellow pine timbers 3¾ × 8 ins., 12 ins. c. to c. These are creosoted with at least 12 lbs. of creosote per cu. ft. of timber. To these are spiked the 2¾-in. transverse white oak floor planks, which are surfaced on one side and both edges. The guard timbers or fenders are of oak, 6 × 10 ins., laid on edge, and having an angle iron ⅜ × 4 × ins. on the top corner. The tracks are laid with 6-in. grooved girder rails, with the guard lower than the tread. They are of the Lorain Steel Co.'s make (Section 77, No. 243) and are secured to the flange angles of the floor stringers by bolted clamps, as shown in Fig. 4. The sidewalks are carried by cantilever floor beams, with four lines of yellow pine stringers 3 × 12 ins. Upon these are the transverse floor planks of maple 3 × 3 ins. Near the middle of the bridge protection against vessels striking the structure is provided by a triangular oak fender 6 × 10 ins., faced with an angle iron 6 × 6 ins., as shown in Fig. 3.

The break in the roadway is on the river side of the pivot, and Fig. 5 shows the way in which the break is faced. The break at the middle of the bridge is shown in Fig. 6. The clearance between the ends of the bottom chords of the two leaves will be 1¼ ins., at a temperature of 60° F., with the bridge fully loaded.

TRUNNIONS AND RACKS.

Each truss revolves upon a pivot pin or trunnion, having two bearings 26 ins. long and 15 ins. diameter, as shown in Fig. 7. From each end a hole is drilled in the center line, and from this a ⅝-in. radial hole leads to grooves on the lower side of the face. The bearings have screw compression grease cups, made to stand a pressure of 500 lbs. The pillow blocks are of cast steel, lined with phosphor bronze, and having bronze liners set between the cap and the main casting. The cap is held by four 1½-in. bolts in slots, and in the base of the casting are 12 holes for ⅞-in. anchor bolts. These bearings rest upon the girders and diaphragms built in the box girders, as noted below.

Upon the curved heel of each truss is a rack, the pitch radius of which is 26 ft. ⅝-in. This is shown in Fig. 2. The teeth are cast-steel bars, bolted between the chord web plates, which are reinforced by flange angle irons on the outside. The pitch of the teeth is 6 ins., and the openings between them prevent the clogging of the rack by dirt or ice, the teeth of the operating pinion dislodging any accumulation, which would then fall through the rack. The rack is built up in segments, having 12 teeth each.

MATERIAL AND WORKMANSHIP.

The structural material will be of open-hearth steel. Test specimens of medium steel must show an ultimate tensile strength of 60,000 to 68,000 lbs. per sq. in.; elastic limit, not less than 35,000 lbs.; elongation, not less than 22% in 8 ins.; reduction of area at point of fracture, not less than 45%. The test piece must bend 180° around a curve whose diameter is equal to the thickness of the piece, and must show no crack or flaw on the convex side. A hole punched for a ¾-in. rivet, 1½ ins. from the edge of a plate, must be capable of being drifted to 1⅛ ins. diameter without sign of fracture. For steel pins the elongation may be 5% less and reduction of area 10% less than above specified. Test specimens of soft steel must show an ultimate strength of 52,000 to 60,000 lbs.; elastic limit, not less than 30,000 lbs.; elongation, 25% in 8 ins.; reduction of area, 50%. In web plates over 36 ins. wide, however, the elongation will be reduced to 20%, and the reduction in area to 40%. The piece must bend cold through 180°, and close down upon itself without sign of fracture on the curved side. A hole punched as above must be capable of being enlarged to 1½ ins. by drifting, without sign of fracture. Rivet steel must have an ultimate strength of 50,000 to 58,000 lbs.; elastic limit, 55% of the ultimate strength; elongation, 27%; it must also bend 180° flat on itself. As to the chemical content, it is specified that the phosphorus must not exceed 0.06% for acid steel, or 0.04% for basic steel.

Cast steel must have an ultimate strength of 62,500 lbs.; elastic limit, 30,000 lbs.; elongation, 20% in 2 ins.; reduction of area, 20%. The phosphorus must not exceed 0.08%. Shafting and forgings must be of medium open-hearth steel; ultimate strength, 60,000 to 68,000 lbs.; elastic limit, 50%; elongation, 25% in 8 ins.; phosphorus must not exceed 0.06%, or sulphur 0.05%.

The diameter of rivet holes must not be more than 1-16 greater than that of the rivet. In riveted work, holes punched in medium steel must be, on the die side, ⅛-in. diameter less than the diameter of the rivet, and then reamed to proper size. Reaming must be done after the pieces are punched and assembled, the burr at the holes being removed by chipping or by reaming tools. The pitch of rivets must not exceed 6 ins., or 16 times the thickness of thinnest outside plate, nor be less than 3 diameters of the rivet. In tie plates, gussets and splice plates, the minimum pitch must be 3 ins. wherever possible. The distance from center of rivet hole to edge of plate must be at least 1½ ins., except that in tie plates the distance may be reduced to twice the diameter of the rivet. For pins and pin holes no play of more than 1-50-in. will be allowed. All rivets will be ¾-in. diameter; rivet holes, 13-16-in.; bolts for rack, ⅞-in.

All iron and steelwork will be cleaned and given one coat of pure boiled linseed oil before leaving the shop, the oil being well rubbed in and surplus oil removed. In riveted work, the contact surfaces will each be given a coat of red lead. Two coats of the same will also be given to the bottom of the bed plates, bearing plates, and parts not accessible after erection. When the bridge is erected, it will be given three coats of paint; the first will be composed of 33 lbs. of red lead to 1 gallon of raw linseed oil; the second, 33 lbs. of red lead, 1 gallon of oil and 1 lb. of lampblack to each 5 gallons of oil. The third, or finishing coat, will be specified by the engineer, and is to cost not less than $1.25 per gallon. The paint must be mixed at the work, and only in sufficient quantities for one day's use.

Owing to the necessity of keeping the waterway free from obstructions, the river arms will be erected on their respective abutments in an upright position. Only sufficient counterweight to properly balance the bridge without the floor will be first placed in position. The two arms will then be lowered to a horizontal position and the trusses properly alined and adjusted. While in a horizontal position and properly adjusted and locked, the lateral angle struts of the floor beams and the transverse connections at the rear of the tail end will, if necessary, be reamed at one end and thoroughly bolted. The arms can then be raised and the bolts removed one by one and replaced by rivets, after which the floor and the additional counterweights can be placed in position, care being taken that only sufficient counterweights are placed to properly balance the bridge with the floor on complete.

LOADING.

The structure is designed for the following loads and conditions: (1) Dead load; actual weight of structure, for river arm about 70 lbs. per sq. ft. (2) Live load: For trusses, 100 lbs. per sq. ft. of roadway and sidewalks. For floor system, hangers and diagonals (counters): Concentrated load resulting from the position of the following loads giving maximum stresses: (A) one street steam roller of 34,000 lbs.; front wheel, 11,000 lbs.; hind wheels, 23,000 lbs.; axles, 10 ft. 9 ins. apart; one front wheel, 24 ins. wide; two hind wheels, 18 ins. wide each and 5 ft. c. to c.; (B) one street motor car, 20,000 lbs. on two axles, 7 ft. 6 ins. apart; and (C) 100 lbs. per sq. ft. on free space of roadway and sidewalks. (3) Wind pressure: (A) lateral bracing; a lateral force of 150 lbs. per lin. ft. of unloaded chord and 300 lbs. per lin. ft. of loaded chord. The 300 lbs. to be considered as moving; (B) trusses, etc.; a wind pressure of 25 lbs. per sq. ft. of exposed surface of moving part, if bridge is opened. The strain sheet given in Fig. 1 shows the maximum and minimum stresses. The weight of one leaf is 320 tons, including structural steel, cast-steel rack, cast iron, timber and counterweights.

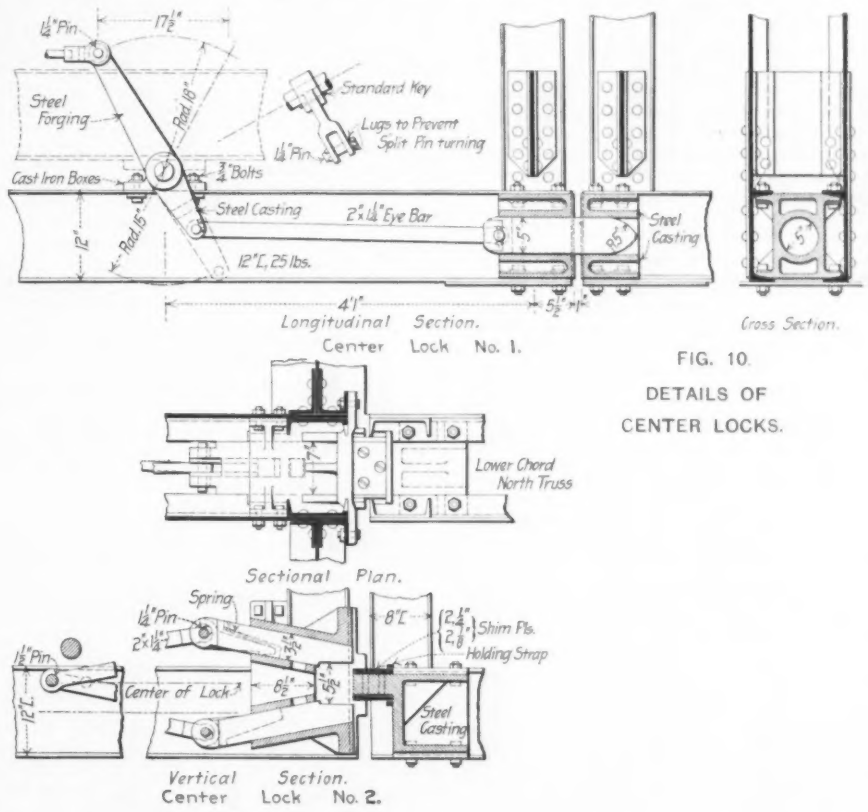


FIG. 10. DETAILS OF CENTER LOCKS.

SUPPORTING GIRDERS AND APPROACHES.

The box-girders which carry the pivot bearings are 32 ft. 3 11-16 ins. long over all. They are arranged in pairs, diverging from each other, so as to be 3 ft. 4 ins. c. to c. on the piers and 12 ft. c. to c. on the abutments. This is done to allow the tails of the trusses to pass down between them. The girders have two web plates ⅝ × 44 ins., 18 ins. c. to c., with top and bottom flange angles. Between each pair of box-girders, midway between the pivot pillow-blocks and pier-bearing block, is a steel casting fitted and riveted to the webs and flanges of the girders, which connects the girders and supports the pivot-relieving shoe when the latter is used.

Across the ends of these girders are laid plate

girder floor beams; the one over the pier is 25½ ins. deep, and the one over the abutment is 28 ins. deep. Midway between these is a 20-in. I-beam. These all support the 12-in. I-beam floor stringers of the approach roadway. The I-beams are 30 ins. c. to c., and have shelf angles on their webs to support the Carnegie steel buckle plates, ⅜-in. thick, laid with the convex side upward. Concrete is filled in over these to cover the beams, and then a 1-in. layer of sand for the 6½-in. wood paving blocks, which will be laid diagonally, except between the rails. The street railway rails are laid directly upon the top chords of plate girder stringers, in the same way as on the bridge floor. The sidewalks of the approach have 10-in. I-beams supporting three lines of 8-in. stringers (the outer ones channels, and the inner one an I-beam). On these are 5-16-in. buckle plates, crowned 3 ins. and covered with concrete 3 ins. thick on the crown. On this is a finishing coat 1½ ins. thick, composed of Portland cement and sand 1 to 1. The concrete for roadway and sidewalk is composed of 1 part Portland cement, 2 parts sand and 5 parts of ¾-in. broken stone.

OPERATING MACHINERY.

The machinery for operating each leaf is placed under the approach roadway, as shown in Fig. 1, and operates the leaf by means of a pinion gearing with a curved rack on the heel of each truss, as already explained. Along the top of the abutment extends a shaft carrying three pinions, and having two sets of driving gear, as shown in the plan Fig. 8, which also shows the position of the buffers, to be described later. Each set of driving gear is driven by a 38-HP. General Electric motor of the railway type (G. E. 67), series wound, waterproof, with steel frame, ironclad armature and gear case. Gear wheels are to be steel castings, mating wheels being so placed that the molding draft of the teeth is reversed. All pillow blocks or shaft bearings will be fitted with screw compression grease cups. The train of gearing shown in Fig. 9 is as follows :

	No. of Teeth.	Pitch of Teeth. Ins.	Pitch Diam. Ins.	Width of Face. Ins.
Pinion (A)	17	2	10.823	5½
Spur wheel (B)	86	2	54.749	5½
Pinion (C)	17	3	16.234	7½
Spur wheel (D)	57	3	54.431	7½
Pinion (E)	17	4½	24.351	10
Spur wheel (F)	31	4½	44.404	10
Rack pinion	12	6	22.918	9½
Rack	72	6	26 ft. ⅝-in. radius	

All main bearings are of phosphor bronze composed of 80% copper, 10% lead, and 10% of phosphorized tin containing 8% of phosphorus. Babbit metal must be composed of 86% tin, 8% antimony and 6% copper.

On each motor-driven shaft is a wheel for a band brake, operated from the bridge-house by a vertical hand lever, with latch handle and notched sector like a reversing lever. The connections from the levers to the brake bands consist of ¾-in. rods. Besides these hand brakes a worm resistance brake is provided at the middle of the main or rack-pinion shaft, and shown in Figs. 8 and 9. A spur wheel (H) on the shaft, 44.563 ins. diameter, and having 40 teeth, gears with a pinion (J), 27.852 ins. diameter, with 25 teeth, on a shaft carrying a worm-wheel (K), which is in line with (but not in gear with) a larger worm wheel (L) on the main shaft. The wheel (K) has a left-hand lead, and the wheel (L) a right-hand lead. These wheels gear into double thread left-hand and right-hand worms (M) and (N), on the shaft of which is a band brake wheel. To prevent resistance or friction in the worm brake when not needed, the worm is revolved by a continuous ⅝-in. hemp rope which passes over grooved pulleys on the motor-driven shafts and the worm shaft. To introduce the resistance, the band brake is applied to the worm shaft, checking the motion of the worm and consequently of the gearing by which it is connected to the main shaft. The brake wheel is of cast iron, 3 ft. diameter, with its rim grooved to carry a steel brake band ¼ × 5 ins., faced with vulcanized fiber blocks ⅛ × 5⅛ ins., secured by 7-32-in. copper rivets. The worms are of phosphor-bronze, composed of 90% copper and 10% of phosphorized tin containing 8% of phosphorus. This must have at least 45,000 lbs. ultimate tensile strength. The worms will run in a bath of castor oil. The teeth of the worm wheels are to be cut with a circular cutter conforming as nearly as practicable to the tooth space of a hobbed wheel mating with the corresponding worm. The entire brake, including the spur driving gear, is to be operated in the shop for 100 hours, or until the worms and wheels have worn to a good bearing. For this purpose, it will be driven by power applied to the larger worm wheel shaft against friction at the brake band. The ratio of the gearing is as follows:

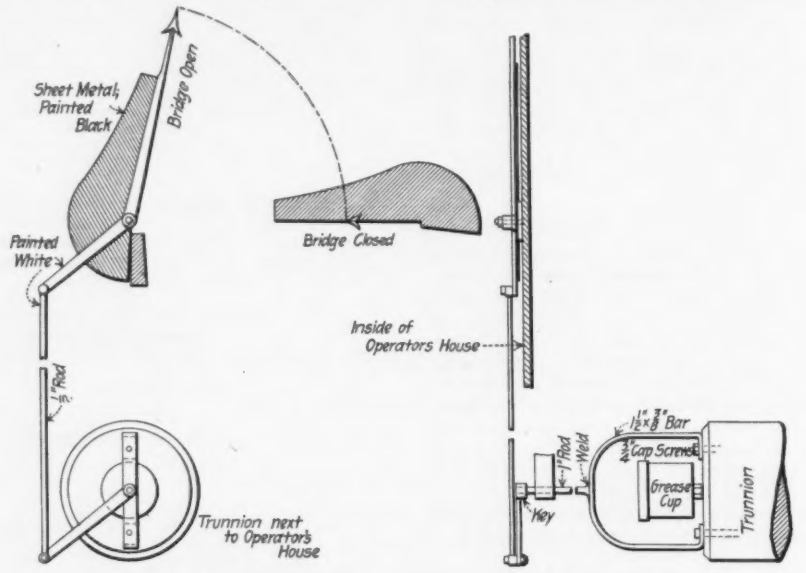
	No. of Teeth.	Pitch of Teeth. Ins.	Pitch Diam. Ins.
Worm wheel (K)	25	3¼	25.863
Worm wheel (L)	40	3¼	41.380
Worms (M), (N)	double-thread	3¼	8.000

Where not otherwise specified, patterns for cast-gear teeth are to be made to templates whose curves shall be involutes of 15° obliquity, with radial line extensions below involute base circles on wheels with few teeth. The curves must be within 1-32-in. of the true involutes, and the variation of the pitch of teeth of patterns for cast gear must not be more than 1-64-in. between greatest and least pitch. The teeth of the rack pinions must have rounded corners to correspond with the inner corner fillets of the rack teeth. The proportions of cast-gear teeth will be as follows: Thickness of tooth, at pitch line = P × 0.475; width of space = P × 0.525; addendum = P × 0.3; dedendum = P × 0.4; and least thickness of rim between teeth = P × 0.5. Here P = circular pitch in inches. Roots of teeth will have fillets of radius equal to 1-7 of tooth space on addendum circle. Molding draft on the teeth of the mating wheels must be as light as possible, while still securing good castings. Teeth of racks will be cast without draft, and rack pinions will have draft each way for center.

All castings will be cleaned and smoothed, and all the machinery will have one filler coat, well rubbed in, and two coats of graphite paint costing not less than $1.10 per gallon.

There will be two operating houses, one on each side of the river. They will be of frame construction, about 8 × 14½ ft. The floors of the machinery rooms will be 6 ins. thick, of concrete (1 Portland cement, 3 sand and 7 stone) on a cinder foundation, and having a ¾-in. surface of cement mortar 1 to 1. There will be an electric bell and five incandescent lamps of 16 c. p. in each house; and 10 lamps in each machinery room. One controller will be placed in each operating house to govern the main bridge motors. It will be of the reversible type, fitted with device for blowing out, and capable of varying and maintaining the speed of the motors from slow speed at the starting point to a maximum speed when full on, without sparking and without shock or jar. It will be of ample carrying capacity to transmit for half an hour without heating 33⅓% above the normal amount required by the motors at full load, or transmit for 5 minutes 50% above the normal amount required by the motors.

Three steel-armored submarine cables of sufficient insulation and capacity to carry safely the necessary current to perform the various operations will be laid by the contractor in a trench 4 ft. deep in the bottom of the river between the two leaves of the bridge. Two cables will be composed of 19 strands of tinned copper wire of not less than 98% conductivity, insulating walls of rubber compound not less than 5-32-in. thick, one winding of tape, a lead sheath 3-32-in. thick containing 3% of tin alloy, a substantial jute serving and an armor of galvanized steel wires of suitable size for the diameter of cable. These cables are to show an insulating resistance of 1,000 megs. per mile after five minutes' electrification. The third cable, for telephone connections, will be composed of four insulated wires. An automatic circuit-breaker will be placed between each feeder and the switchboard. Each submarine cable, each line to motors, and each lighting circuit will also be protected by suitable cut-outs.



Side Elevation. End Elevation.

FIG. 12.—SKETCH SHOWING OPERATION OF INDICATOR.

The specifications state that the machinery is so designed that the opening of the bridge, from the moment it is closed to traffic to the moment when the leaves reach their highest position, will not take more than one minute in calm weather, or 2½ minutes with a 70-mile wind blowing in a direction unfavorable to the operation of the bridge. In regard to the operation of the bridge, it may be stated that the center of gravity of each leaf is in the front of and above the trunnion. This causes the leaf to have a tendency to remain in its two extréme positions when closed or opened. Owing to this tendency, no tail-locks are needed, as on some of the other Chicago bascule bridges, where this mechanism is said to be troublesome to keep in operation and repair, requiring frequent adjustment. The drag of the machinery is under ordinary circumstances sufficient to overcome any tendency of the leaf to run away, and therefore the leaf will remain in equilibrium at any point of rotation when brought to a stop. One motor is sufficient to operate one leaf under ordinary circumstances, and the machinery is so arranged that when one motor is disabled the other can operate the bridge without interruption. The bracing in the bridge is made sufficiently strong to allow the leaf to be operated in case any of the rack pinions should break. The leaf can also be operated if the two outside rack pinions should break. In general, the machinery is so arranged that when any part is disabled this piece can be removed at once and the operation can go on uninterruptedly until a new piece is substituted.

In the pit of each abutment there will be a horizontal centrifugal pump, on a vertical shaft, and having a capacity of 250 gallons per minute with a lift of 16 ft. These pumps will serve to drain the tail-pits, and each will be driven by a 2-HP. electric motor.

CENTER LOCKS.

Two alternative forms of center locks have been devised, both of which are shown in Fig. 10, and the city has reserved the right to use either of these. In the first form, No. 1, a cast-steel locking bolt 4-31-32 ins. diameter slides horizontally in steel castings bolted to the ends of the trusses, and bored out to 5 ins. diameter. In the second form, No. 2, a fixed plug or stud is bolted to the end of one truss, and when this has entered a vertical slot in a casting on the end of the other truss, two inclined sliding jaws are moved forward so as to come in contact with the top and bottom of the stud. The stud is fitted with shifting plates by means of which changes of vertical alinement can be corrected. In either locking device the shaft is connected by a lever with two rods extending back along the lower chord of the leaf to rocker arms located back of the pivot. When the leaf is down, these rocker arms engage with clutch arms on a locking shaft on top of the pier. A bevel wheel on the end of this shaft gears with a bevel pinion on a vertical shaft operated by a hand-wheel in one bridge-house. The controller and the hand-wheel are so interlocked that the lock cannot be operated until the bridge is closed and the machinery at rest.

END LOCKS AND BUFFERS.

When the bridge is closed the center of gravity of each leaf is on the river side of the pivot, and as the movable part of the roadway does not extend back of the pivot it is only necessary to lock the leaf against further downward movement. This is done in connection with the bridge closing buffers by allowing the leaf to pull the lower buffer pistons against the cylinder heads, the cylinders being anchored to the masonry.

Pneumatic buffers are provided to arrest the motion of the leaf at each end of its travel, and are an interesting feature of the machinery equipment. These are shown in Fig. 11. In closing, the action of the buffer is as follows: When the leaf is near the end of its movement, a hooked lug (A) at the lower end of the curved back of each truss picks up a 6½-in. pin (B) which is connected by eye-bars to a combined cross-head and piston (C). The movement forces the piston upward in an inverted cylinder (D), meeting the increasing resistance of the air in compression, which absorbs the energy of the closing leaf. When the pressure reaches 350 lbs. per sq. in., the air escapes through a spring relief valve and allows the piston to rest against the cylinder head above it, thus acting as an end lock, as noted above. As the leaf starts to open, a second lug (E) near the hook above mentioned, returns the buffer and connections, by means of a hooked lever (F), to the position in readiness for closing.

The action of the upper buffer in arresting the leaf at the end of the opening movement is similar to that of the lower buffer, the difference being that the upper buffer is operated through an intermediate lever (G) pivoted to a special pair of stringers of the approach roadway, which stringers also support the upper buffer cylinders (H). The rear end of the lever acts on the piston (J) through a short link (K). The front end of the lever is operated on in essentially the same manner as the pin of the lower buffer, by two lugs located at the upper end of the curved back of each truss. One of these is shown at (L).

The buffer cylinders are 17½ ins. diameter with an effective stroke of 18 ins. The pistons are packed by two cast-iron snap piston rings.

GATES AND SIGNALS.

At the shore end of the right-hand roadway on each approach will be a pivoted gate, moving in a vertical plane, similar to those used at railway crossings. The arm of each gate will be lined with an iron strap ⅛ × 2½ ins. These gates will be operated by hand air-pumps located in the operators' houses. On the outer ends of the top chords of the two outer trusses of each leaf will be an ornamental iron post supporting a revolving target and lamp. The target will be 24 ins. diameter, red and white. The lamps will have 9-in. lenses, red and green. The height from top of chord to top of target will be 7 ft. 4 ins.

INDICATOR.

Each bridge-house is fitted with an indicator showing the angular position of both leaves, as illustrated in Fig. 12. A stirrup on the end trunnion has a rod coinciding with the center of the bearing, and this carries an arm with lever connections to a pointer and sheet-steel outline of truss in the house.

BOOK REVIEWS.

DYNAMOMETERS AND THE MEASUREMENT OF POWER.—A Treatise on the Construction and Application of Dynamometers; with a Description of the Methods and Apparatus Employed in Measuring Water and Electric Power. By John J. Flather, M. Am. Soc. M. E., Professor of Mechanical Engineering in the University of Minnesota. Second edition. Revised and enlarged. New York: John Wiley & Sons. Cloth; 5 × 7½ ins.; pp. 394; 116 illustrations. $3.00.

In the present edition of this book five new chapters have been added and some of the original chapters have been rewritten. Of the new chapters, four are upon the measurement of electrical power and one is devoted to the power required to drive machinery. The information contained in this chapter has been collected from a large number of tests and covers most types of machine tools. It alone should render the book of great value to the engineer. The titles of the various chapters are as follows: Determination of Driving Power; Friction Brakes; Absorption Dynamometers; Transmission Dynamometers; Measurement of Water Power; Measurement of Electrical Power; Instruments for Measuring Electrical Power; Methods for Measuring the Power of Direct-Current Motors; Methods of Measuring the Power of Alternating-Current Motors; Power Required to Drive Machinery, and Analysis of the Power Required to Drive Lathes.

WÖRTERBUCH DER ELEKTRICITÄT UND DES MAGNETISMUS; Ein Handund Nachschlagebuch mit deutschen, englischen und französischen Worterklärungen. —By Prof. W. Wieler, Leipzig: Moritz Schäfer, Philadelphia: Schäfer & Koradi. Cloth; 7½ × 10½ ins.; pp. 632; 816 illustrations. $4.50.

This dictionary is designed to serve as a hand and reference book on the subject of electricity and magnetism. The definitions and explanations are as a rule very clear and they are often supplemented by cuts. Fundamental laws are stated in a concise and lucid manner. There are many mathematical tables and tables of physical constants. About the only feature calling for adverse criticism is that in practical matters the book is not thoroughly up to date. In the appendix lists of English and French terms are given, together with the German equivalents.

MODERN ELECTRIC RAILWAY MOTORS.—A Discussion of Current Practice in Electric Railway Motor Construction, Maintenance and Repair. By George T. Hanchett, S. B., M. Am. Inst. E. E. New York: Street Railway Publishing Co. Cloth; 6 × 9 ins.; pp. 196; 157 illustrations; tables. $2.00.

The construction and the operation of electric street-railway motors are exhaustively treated of in this book. The work is thoroughly practical, much space being devoted to the details of modern commercial motors and descriptions of the forms through which these details have passed in the process of being perfected. The headings of the chapters are as follows: Forms of Field Magnets; Armature Winding Diagrams; Field Coil Construction and Arrangement; Armature Construction; Commutators and Brush Holders; Motor Casings; Motor Suspensions; Bearings and Gears; Lubrication; General Data and Dimensions; Management and Repair; The Design of a Street Railway Motor.

MACHINERY AND ELECTRICITY AT THE PARIS EXPOSITION OF 1900.—Charles Dunod, Editor, 49 Quai des Grands-Augustins, Paris. Paper; 9 × 12 ins.; illustrated; 50 francs.

This series of publications, to which we have given the somewhat arbitrary title of "Machinery and Electricity at the Paris Exposition of 1900," is intended to comprise 20 monographs covering in some detail the various machines and electrical appliances exhibited at the Paris Exposition of last year. The two monographs which have so far appeared cover "Telephones and Telegraphs" and "Artillery," and contain respectively 131 and 160 pages. Among the monographs which are to appear are: "Steam Boilers," "Pumps," "Mechanical Applications of Electricity," "Steam Engines," and "Agricultural Machinery." Each monograph is written by a prominent French authority on the subject dealt with, under the editorial supervision of a Board of Editors composed of prominent engineers and scientists. The two monographs which have appeared bear evidences of careful selection and painstaking work, and the series would seem to be one of unusual value to persons interested in securing an early account of what the Exposition had to show in the line of machinery and electrical appliances.

WATER POWER.—An Outline of the Development and Application of the Energy of Flowing Water. By Joseph Frizell, Hydraulic Engineer, M. Am. Soc. C. E., M. Boston Soc. C. E. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 563; illustrated. $5.

Within a comparatively few years the wonderful advance in the applications of electricity and the possibility by its aid of transmitting power over long distances have brought about a radical change in the value of and development of water power. Cataracts which were once too remote from industrial centers to be considered worthy of notice, can now be usefully applied, and in the multitude of new motors and appliances and the general economy resulting from a more thorough and scientific study of this subject, we have what is essentially a new field of engineering practice in the development and application of the energy derived from flowing water. Mr. Frizell recognizes these changed conditions, and is practically the first to give to engineers a comprehensive and thoroughly up-to-date treatise upon a branch of engineering that is constantly increasing in importance.

This work is in no sense elementary; the author assumes that the reader possesses some fundamental notions of mechanics and mathematics, and he uses mathematics freely when this use is essential to an intelligent understanding of ruling principles. But, on the other hand, the new practice is so plainly set forth and illustrated by examples taken from existing power plants, that the treatise is exceedingly useful, even to the man who has forgotten his higher mathematics. The following brief outline of the various heads discussed will give some idea of the scope of the author's work:

Natural water courses; the differences in rainfall and stream flow in various parts of the United States; and the effect of geological formation upon this flow, are considered in an introductory chapter. Dams are then taken up, first mathematically and then with reference to the details of construction, in such different materials as timber and earth, logs, timber and stone, crib work and masonry. The masonry dams have a chapter to themselves; and Mr. Frizell expects to see a constantly increasing proportion of masonry dams built as a result of the increasing cost of timber, the diminished cost of masonry and the greatly diminished rates of interest upon the investment. In connection with this latter point he gives some simple formulas for the computation of interest charges. Various typical masonry dams are illustrated and described; and another chapter deals with failures in masonry dams, including that of the Colorado River dam, at Austin, Texas, of which the author was the original engineer, but resigned before completion. He practically charges the failure of this dam to the undue influence of the contractor upon the local authorities, and to the interference with the engineer's plans by these authorities. Following the discussion upon dams we have a chapter upon canals, waste ways, gates and other appendages of a dam.

Hydraulic motors and water wheels naturally receive much attention. Each type is described separately with all their accessories, and the principles underlying each are mathematically investigated. A chapter on the development of natural water powers includes the description of a number of prominent power plants in the United States. The transmission of power is handled in separate chapters and covers transmission by shafting, by wire-rope, by compressed air, by electricity and the storage of energy by pumping. Here, again, we have a mathematical discussion of the various forms of transmission, and the details of their application at many points. The measurement of water is treated according to the latest practice, and an important chapter is that on the storage and pondage of water, the cost of steam power, effect and value of reservoirs and the economic relation of reservoirs to coal. The closing chapter is devoted to the computation of damages to mill owners resulting from the diversion of water.

The author has well covered his field, and the result is a work that will be exceedingly useful to the engineer desiring to apply the latest and best practice to the development of water power.

THE STEAM ENGINE INDICATOR.—By Cecil H. Peabody, Professor of Marine Engineering and Naval Architecture, Massachusetts Institute of Technology. New York: John Wiley & Sons. Cloth; 5 × 7½ ins.; pp. 152; 98 illustrations. $1.50.

This small volume deals quite exhaustively with the construction, care and use of the steam engine indicator. The usual methods of taking diagrams and the conclusions and inferences to be drawn from the same are explained. In connection with this the thermodynamic properties of steam and air are treated of. Considerable space is given to a discussion of the several types of planimeters, and the geometrical theory of their action is explained in a simple manner. The reducing motions and indicator rigs commonly used are shown by diagrams. This book should be of much assistance to the student or to others who are unfamiliar with the steam engine indicator and are called upon to use it.

DESIGN AND CONSTRUCTION OF OIL ENGINES, With Full Directions for Erecting, Testing, Installing, Running and Repairing. Including Descriptions of American and English Kerosene Oil Engines.—By A. H. Goldingham, M. E. New York: Spon & Chamberlain. Cloth; 5 × 7½ ins.; pp. 196; 79 illustrations. $2.

This is a most excellent manual on the design and operation of oil engines, by which is meant internal combustion engines using oils having a specific gravity varying from .78 to .85 with the flashing point between 75° and 300° F. No attempt has been made to discuss the thermodynamics of the subject, but the book contains much practical information of value both to the draftsman and the engine tender. The notes describing the design and method of operation of the different types of oil engines are concise and reasonably full and would be very useful to any one having to take charge of an oil engine.

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The long and much-needed sewerage and paving work in Havana, Cuba, bids fair to be entered upon at last, and with a prospect of full and free competition, and thus a hope of fair prices for the work. In our news columns we publish the substance of a dispatch sent to this journal by Governor Wood, in which he states that bids will be invited soon, with no special privileges reserved to any one. This means that all contractors within reach of Havana may bid on the work without fear of having the contract taken away from the lowest bidder under the claims which have been pressed so vigorously and persistently by Mr. Michael Dady, a Brooklyn contractor, who had nearly completed a contract for the work in question when the Americans occupied Cuba, and who claimed the Spanish right of tanteo, or taking the work at the lowest price offered, in case public bids were invited. As the contract involves many millions of dollars, the bidding for it should be lively.

How thick may the shell of an ordinary externally-fired return-tubular boiler be safely made? This question is discussed by Mr. Robert S. Hale, M. Am. Soc. M. E., in a circular recently issued by the Mutual Boiler Insurance Co., of Boston, and he advises that the thickness of shell plates in such boilers, and hence the size and the steam pressure, may be considerably increased over the present usual practice without any danger. As proof of the faith that is in him, he states that his company stands ready to insure boilers with shell plates 9-16-in. thick. This thickness, with joints quadruple-riveted, will permit 170 lbs. pressure to be carried on a 72-in. boiler with a factor of safety of 5, or 135 lbs. pressure on a 90-in. boiler. He estimates the cost of a 90-in. boiler complete with setting at $2,000, and shows that with a rating of 400 HP. this cost is only $5 per HP.

It will be evident that the larger a boiler of this type can be made, the lower will be its cost per horse-power. The reasons for limiting the thickness of shell plates in the past has been the prevalent theory that a thicker plate offered more resistance to the transmission of heat and rendered the plate more liable to overheating and consequent injury. As Mr. Hale correctly shows, this theory is erroneous. He computes (from the known conductivity coefficient of iron) that a plate so thick as 1 inch, transmitting heat so rapidly as to evaporate 50 lbs. of water per hour from and at 212°, will have a difference of temperature between its two sides of only 168°. Assuming, then, a steam pressure of 150 lbs., corresponding to a steam temperature of 365°, Mr. Hale concludes that the temperature of the fire side of the plate will be only 365° + 168° = 537°.

In this computation, however, Mr. Hale has made one error. He has omitted to include the difference in temperature between the water side of the plate and the boiling water in contact with it. It is true that under low rates of heat transmission this difference is in all probability only a few degrees; but exactly how much it is we do not know, and no experiments have ever determined. What we do know is that this difference varies with the rate of heat transmission, and also with the speed of circulation of the water over the surface of the plate, perhaps also with the violence of the ebullition which induces circulation. In what proportion it varies is, however, unknown. Practical experience indicates that while with all ordinary rates of heat transmission the heating surface can take care of itself, when the fire side of a plate is exposed to very high rates of combustion the difference in temperature between the plate and the water may reach a considerable amount. It is, therefore, necessary in such cases to take especial care that rapid and continuous circulation shall not be interrupted, that free escape for the steam bubbles is provided, and that grease or scale or dirt does not interpose a non-conducting layer between the plate and the boiling water. As a practical illustration: it makes little difference what the circulation is around the smoke-box end of locomotive boiler tubes, whereas even with the best of care the tubes near the fire-box end gradually become overheated and burned away.

We do not call attention to the above error with any idea of questioning the correctness of Mr. Hale's approval of a 9-16-in. plate as safe for use in boiler shells; but merely in the interests of correct statement. On the other hand, while few competent engineers, we believe, will question Mr. Hale's approval of the 9-16-in. plate, it is an open question how much farther it is safe to go in increasing the thickness of shells of externally-fired boilers, especially when such boilers are to be used with high steam pressures and with high rates of cumbustion. Even though it be true that the actual temperature of the plate on the fire side may not be so great as to cause dangerous overheating, as we increase the difference between the fire and water sides of the plate we are increasing the temperature stresses and setting up various internal strains tending, perhaps, to deform the boiler shell and to hasten corrosion by grooving The stiffness of the quadruple-riveted joint, and the effect of heating the circumferential seam where exposed to the fire are also matters which might give trouble were so radical a departure made, for example, as a 1-in. boiler shell. Mr. Hale does not, in fact, advocate so radical a change. He only indicates that the upper limits to the thickness of such plates are at present unknown. This is correct; but it is not at all unlikely that such limits exist, and that experience will finally reveal them.

The practical lesson which Mr. Hale would teach is that the present prejudice against the use of higher pressures and larger sizes of externally-fired boilers is unjustifiable. He is right, to the extent indicated above; and yet is it wholly in the direction of better engineering practice to encourage the use of this type of boiler under such conditions. We do not say this type of boiler is unsafe. Safety is a relative term. Absolutely speaking, every steam boiler is a source of danger. What we would point out is that the "record of fatality" of this type of boiler is so much worse than that of the Scotch boiler or the Lancashire boiler or the water-tube boiler, that it is questionable whether its perpetuation is a "survival of the fittest." It is true that explosions of boilers of this type, when well made and properly inspected are not frequent. Boiler insurance companies insure and inspect them without question, of course. But there is something disquieting to the nerves in chaining down a hundred million foot-pounds of stored energy and setting a seething furnace to heat a link of that chain. So long as the water is there to keep the chain cool, well and good; but try as you may, sometime and somewhere, any one of a dozen causes may interfere with the cooling of the chain. It grows hotter, reddens, weakens, and in an instant the mighty force, so long held down, is set free. The old externally-fired boiler is a good boiler; but why not use a safer one?

THE COMING EXHAUSTION OF NATURE'S STORES.

What is the greatest task before the engineer—using the term in its broadest sense—in the century just opening? We have had his work in the nineteenth century well set forth in the familiar definition: Harnessing Nature's great powers for the service of Man. The engineer has made steam and electricity, winds and waters take the place of human and animal muscle. He has contrived machinery to replace the hand and the hand-tool. These great tasks have belonged to the century just closed. In that which has just opened it will be the greatest task of the engineer—be he chemist, inventor or what not—to face the problem of the world's falling stocks in Nature's storehouse.

When future generations look back upon the nineteenth century, whose work we now regard with such pride, it is quite possible that their chief sensation will be wonder at the profligate waste that characterized the people who first made large use of the earth's stored-up riches.

We shall not be far from the truth if we say that, until the nineteenth century, mankind was content to live off the annual produce of the earth. A trifling use was made, indeed, of the fuels and metals and minerals stored beneath the soil, but it was a mere nothing compared with the drafts which the closing years of the nineteenth century have made. A moment's thought will show the truth of this statement. Take our most used mineral, coal. When the nineteenth century began, the railways and steamships, which now make such enormous drafts on the world's coal seams, were undreamed of. The stationary steam engine had had its beginning, but its use was still so limited that it cut no figure at all in the world's coal consumption. The principal use of coal was for household fires and for the crude metallurgy of the day, and this only in countries like England, where the removal of the forest growth had caused a scarcity of wood and of its product, charcoal.

With no railways, no steamships, no factories and mills, the consumption of metals was almost as trifling as that of coal. Not until the nineteenth century, and indeed not until the last two-thirds of that century, did mankind begin to make any appreciable drafts upon the treasures laid up in Nature's storehouses.

For the last 50 or 75 years, however, the use of these stored materials has been prodigious. Each year sees an increase in the consumption of all the things which the earth yields; and we are accustomed to point to this growth as evidence of the world's advancement in civilization. Is it not time to ask ourselves whither all this is tending? A man cast on a desert island who should fail to take account of his supplies and then plan to husband those in which scarcity threatened, would justly suffer for his improvidence. Is it not time that mankind took account of its rapidly diminishing stores of natural wealth in order that

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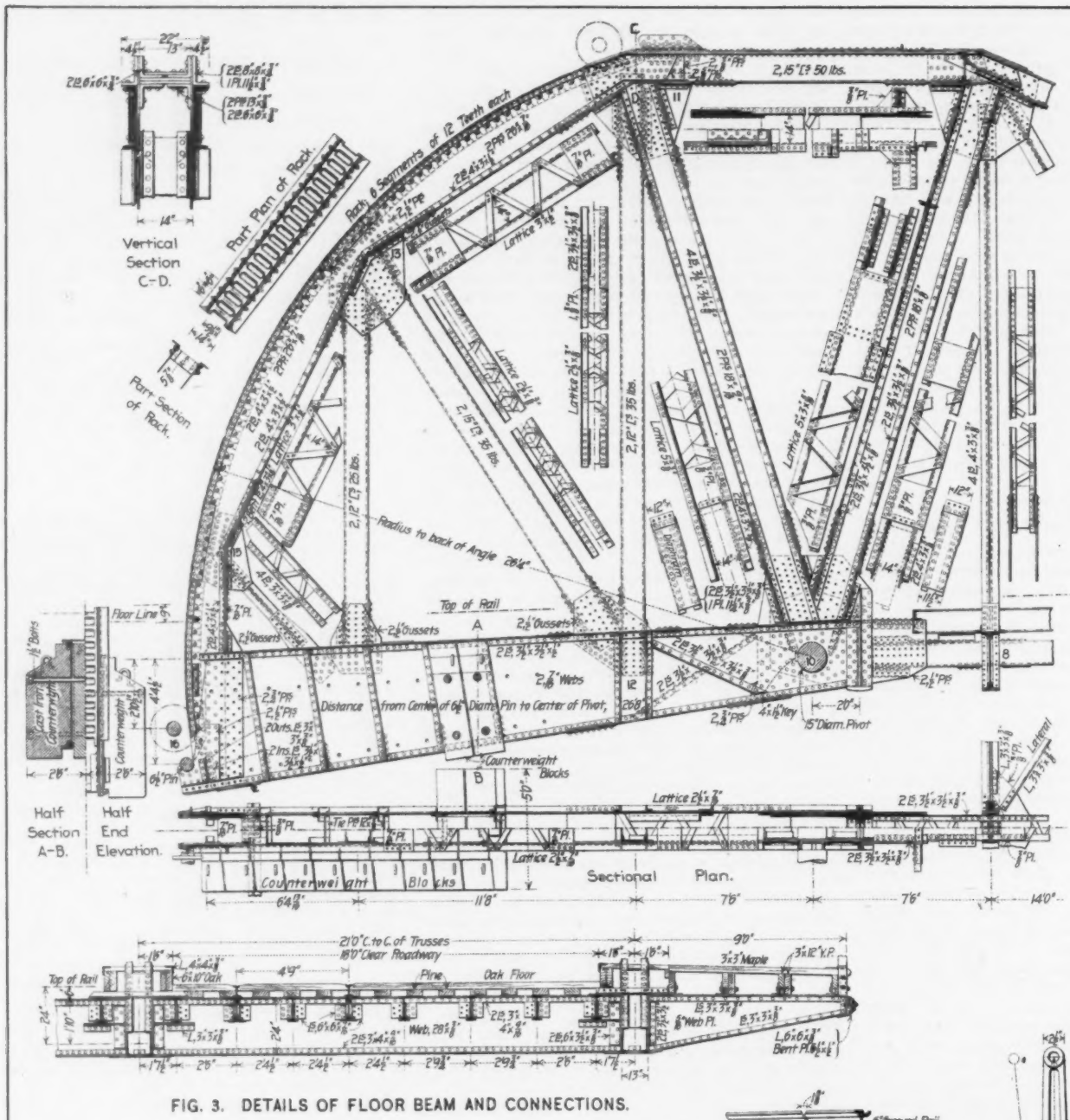

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FIG. 3. DETAILS OF FLOOR BEAM AND CONNECTIONS.

FIG. 5. DETAILS OF BREAK IN ROADWAY AT END OF SPAN.

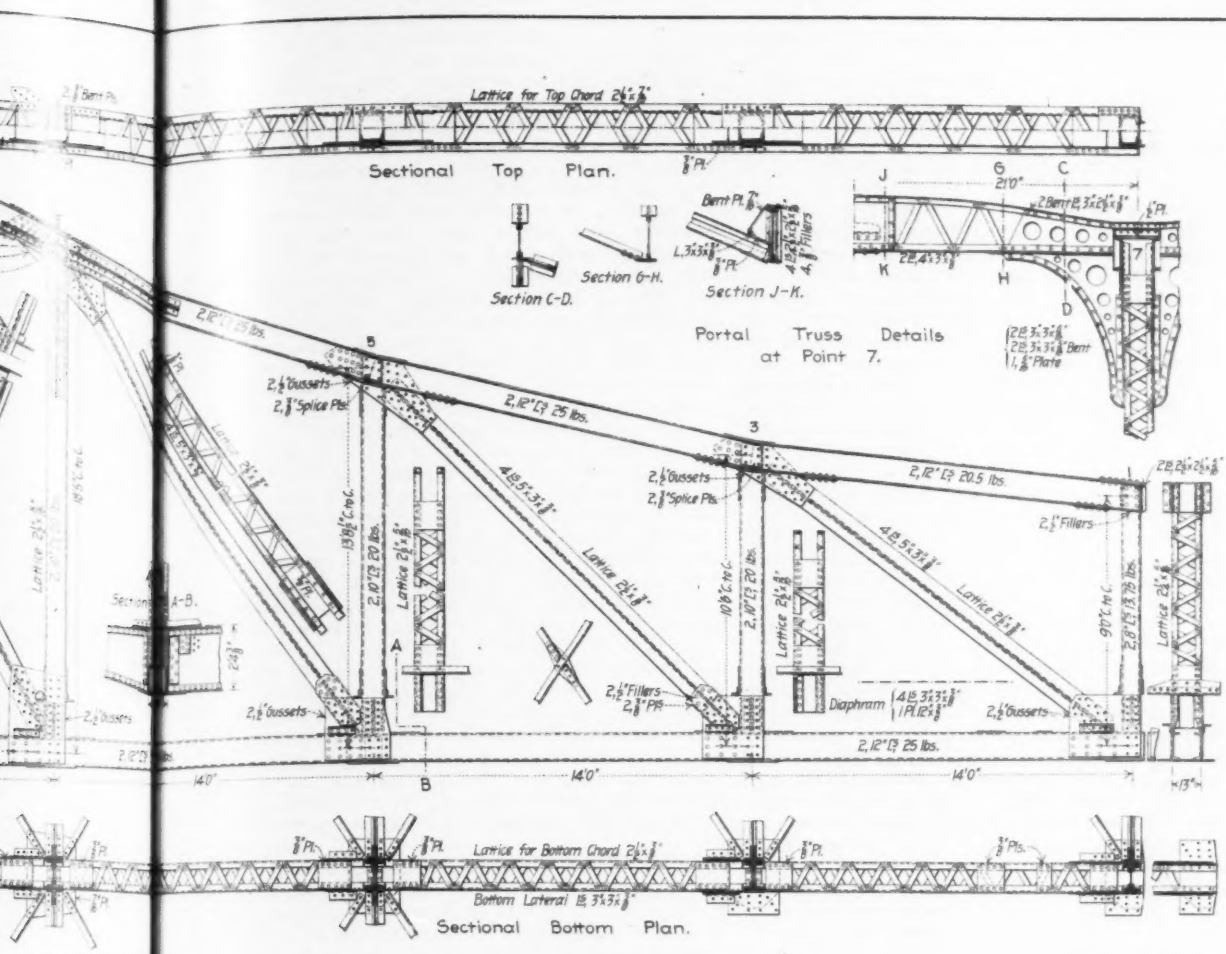
FIG. 6. DETAILS OF BREAK IN ROADWAY AT CENTER OF SPAN.

FIG. 11. SKETCH SHOWING OPERATION OF PNEUMATIC BUFFERS.

BASCULE BRIDGE OVER CHICAGO R

John Ericson, City Engineer;

DETAILS OF TRUSS.



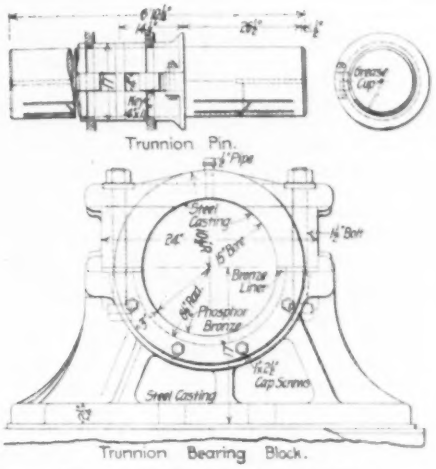
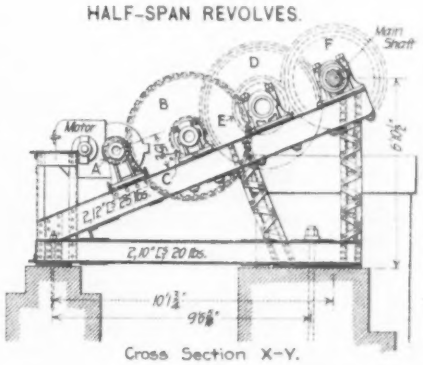


FIG. 7 DETAILS OF TRUNNION ON WHICH HALF-SPAN REVOLVES.



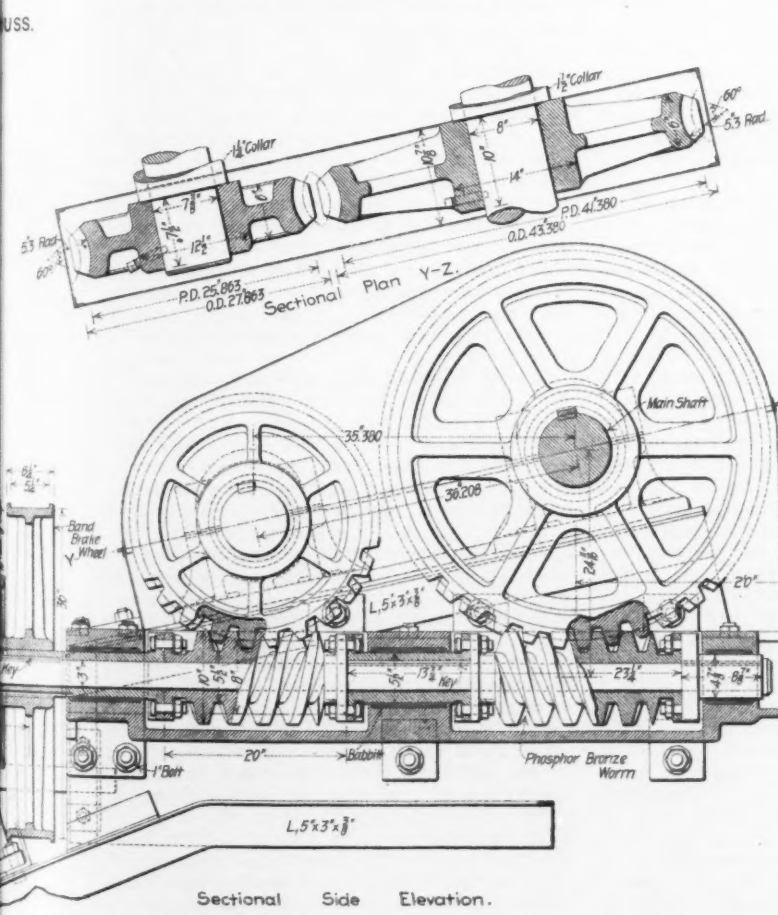


FIG. 9. SECTIONS SHOWING DETAILS OF WORM BRAKE.

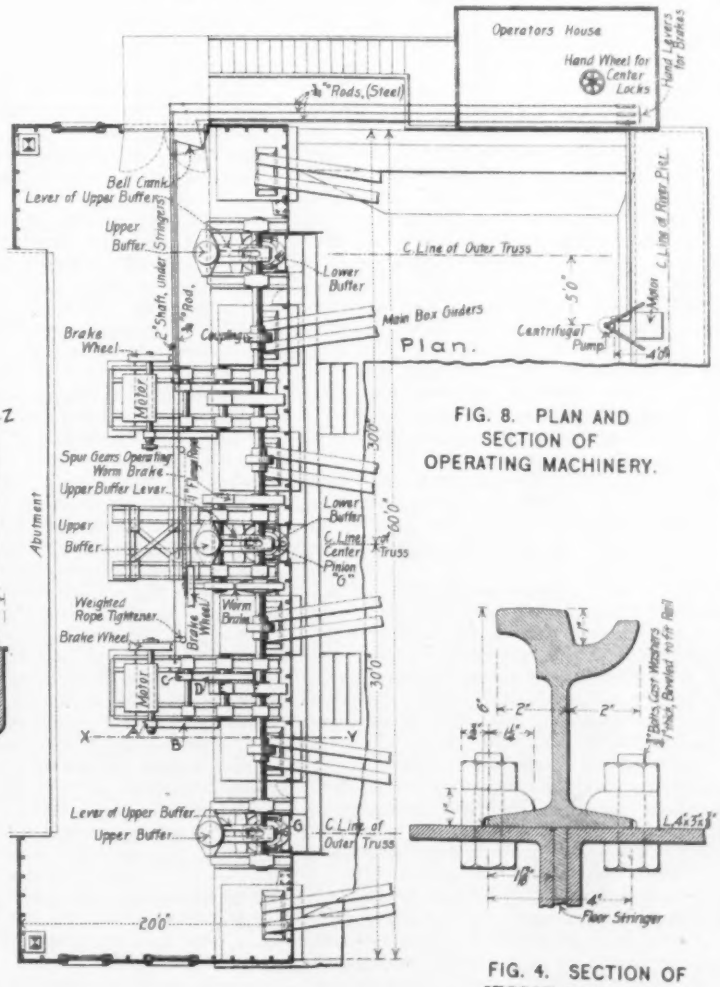


FIG. 4. SECTION OF STREET RAILWAY RAIL ON BRIDGE.

CHICAGO RIVER AT CLYBOURN PLACE, CHICAGO.

Edward Wilmann, City Bridge Engineer.

CHAS. HART, LITH., 29 VESEY ST., N. Y.

means may be provided for husbanding such as seem likely to be first exhausted.

Something in this direction has indeed already been done with respect to certain commodities in which scarcity is already impending. Investigations have been made of timber consumption, of the stocks of unmined coal, of the prospect that the supply of gold will be equal to the demands of commerce, of the growing scarcity in many species of food fishes which once swarmed in rivers and seas. There is great need, however, for more investigations of this class, and for the dissemination of more accurate information upon these subjects. The popular mind, so long educated to the profusion which nineteenth century commerce has created, hardly comprehends the possibility of a world-famine in any article. The wonders of invention and of science have bred an abiding faith in their ability to meet all exigencies. It is not comprehended that neither the engineer nor the scientist can make something out of nothing. They can only apply old things to new uses and devise means for the more economical and effective application of natural resources.

The most important of all questions which concerns the future of the race is, of course, the problem of food. We shall not discuss here the new meaning which the ancient doctrine of Malthus is coming to have, in view of the enormous growth in population of the civilized world during the past century. What we wish to point out is that the food supply of a great part of the world has been drawn during this century from the virgin soil of North and South America. The opening of a new century finds nearly all this virgin soil now under tillage, and much of it so exhausted of its fertility that artificial manuring is necessary to enable it to maintain its productiveness.

The chief chemical elements necessary to a fertile soil are nitrogen, potash and phosphorus. The nitrogen, we may yet be able, with the chemist's help, to secure from the atmosphere; indeed, it is now so obtained by the slow processes of plant life; but no such ready resource is available for potash and phosphorus. The old-time resource of the farmer—wood ashes—meant merely robbing the forest soil of potash to place it on the soil of the field. The only extensive mineral deposits of potash salts in the world, we believe, are the Stassfurt mines in Germany (owned by a trust!), and the supply of potash to maintain the fertility of the world's grain fields may before the close of the century become a matter of international concern. In this connection, it may be remarked that the irrigation of arid regions and the utilization of the alkalies accumulated in their soils may assume an importance in future years, when the soil of humid regions becomes exhausted, that is now undreamed of.

For phosphorus, even more necessary than potash to soil fertility, the farms of the world are now largely dependent upon the fossil stores accumulated by the animal life of remote geologic ages. So long as this lasts, well and good; but little is known as to the extent of these deposits, or the time for which they can be counted on to supply the world's needs.

The dependence of modern civilization upon coal has been so often pointed out, that we need not enlarge upon it here. Fortunate it is that the stores of coal on this continent are so vast that they may be considered well-nigh inexhaustible. On the other hand, an increased cost of coal is certain to result from the gradual exhaustion of the best and most easily-worked seams. Such an increase has already been experienced in Europe and is quite certain to be a notable factor in international industrial competition, and one of constantly increasing importance as the century advances. In the United States the same influences will be felt, but to a lesser degree. With the increased cost of coal will come an increased use of other natural forces to develop power. The closing decade of the nineteenth century, indeed, has witnessed a return to the use of water power (due to other causes than increased cost of coal); and the present century will see, we may be sure, much greater applications of this natural agent, and also of the forces of the tides, the waves, and the winds. It is not unlikely, for example, that before the close of the present century, sailing ships will displace steam vessels for a large part of the ocean freight traffic.

We may thus economize in the use of coal to generate power; but when heat is desired, nothing but fuel will serve. Those choicest fuels in nature's laboratory, natural gas and petroleum, will be exhausted long before the stock of coal is appreciably diminished. In fact, there is no better illustration of the world's improvidence in its use of Nature's choicest gifts than the waste of petroleum and natural gas which has taken place in the century just closed. Had the stores of natural gas in the Pennsylvania, Ohio and Indiana fields been strictly preserved and used only for such purposes as glass and pottery manufacture, the supply might have been made to last for a century or more, and would have been an enormous boon to the world at large, and a source of incalculable wealth and prosperity to these states. Instead, this new and wonderful fuel was wasted as prodigally as if the supply were inexhaustible, and it was used in a hundred ways where coal had served and would have served practically as well. The result, of course, was the rapid exhaustion of the supply; and its practical disappearance as a factor in modern industry will probably take place in little more than a quarter century from its first extensive utilization.

The world's supply of petroleum will last for a much longer time before ultimate exhaustion occurs; yet the time cannot be far distant when increased demand and diminished production will cause an increased price. Men will look back in future years and wonder at the folly of a generation which burned and wasted so prodigally this choice gift of Nature. If an autocratic ruler of the human race could forbid its use from this time forward, except in those arts where its use is vastly important, and its loss would be a world calamity, such a decree would work great benefit to future generations and little injury to those living at the present day.

Much more might be said concerning the great economic and industrial changes which will result during the present century from increasing scarcity of mineral fuels, but space permits only a reference to the probability that such low-grade fuels as lignite and peat, now of little commercial importance, will probably acquire great value as substitutes for coal before the close of the century.

Turning now to metal productions, the most useful metal, iron, is fortunately so widely distributed that a serious and world-wide scarcity seems now too far in the future to be foreseen. On the other hand, long before this century is closed, the richest and most accessible ore deposits will probably be exhausted; and resort will be made to the far more extensive deposits of low-grade ores. The greater cost of reducing these, in combination with the increased cost of fuel will probably make iron more costly during the present century than it is now at its opening. Actual scarcity in this most valuable of metals however, cannot now be foreseen.

Of other industrial metals, tin is the one which seems likely to be soonest exhausted, the deposits of this metal rich enough to work being exceedingly few. Copper, which is of much greater importance in the arts, stands in much the same position as iron. The high-grade deposits, such as those of Michigan, Montana and Chili, will probably be worked out long before the present century has closed; but there are deposits of lower grade ore much more widely distributed, which, with improved processes of reduction, may, it is to be hoped, maintain the world's supply with no great increase in price for an indefinite period. The supply of copper will be conserved, moreover, through the fact that its corrosion loss is far less than that of iron, so that the annual loss from the world's stock by use is far less.

Zinc and lead will probably experience an increase in price as the most available deposits are worked out; but this increase will cut off a large part of their use. Before the century's close, aluminum, the raw material for which is practically unlimited in amount, will probably be largely substituted not only for tin and copper, as has, indeed, already happened, but for lead and zinc as well. In fact, it is doubtful whether any chemical discovery of the past century will prove of greater importance to the future welfare of mankind than the development of cheap processes of aluminum production.

Among the rare metals, mercury and platinum are the two which are likely to be soonest exhausted. The usefulness of these two metals, especially in the chemical industries, is so great that their loss would be a calamity, especially as in many places no known substance could serve as a substitute. The workable deposits of these metals, especially of platinum, are exceedingly few; and no important discoveries of new deposits have for many years been made.

Upon the much disputed question as to the ability of the world's gold deposits to supply the rapidly-increasing demands of commerce and industry, we cannot now enter at length. It can only be said that if alluvial sands had remained the sole source of supply, the world would ere this have had to face the fact that its standard of values was itself rapidly appreciating in value through the inexorable law of supply and demand.

The development of cheap processes of mining and milling gold ores, with such chemical methods of extraction as chlorination and the cyanide process, have enormously increased the world's gold production in the closing decade of the nineteenth century. If this production can be maintained (and this can be done so long as low-grade ores exist or can be found of sufficient extent), the supply of gold is ensured which the expanding commerce of the world demands, in order that the value of its standard shall remain constant. When this supply fails, the question of the metallic standard of values will doubtless have to be opened anew.

Passing from metals to minerals, it is a fortunate fact that the world's stock of the most useful and durable of minerals—building stone, clay and cement-making material—is inexhaustible. This fact, we may be sure, will have a large influence upon the work of the engineer of the future. It is not difficult to foresee a time when with timber practically exhausted and metals grown too scarce and expensive for structural use, a return will be made to the stone structures which were so prominent a feature of an earlier period of history.

Even now, at the beginning of the new century, we see concrete and stone taking the place of steel, and there can be little doubt that this substitution will continue in much larger measure in coming years. In fact, one can easily foresee the time when men will wonder at the fatuity with which in the nineteenth century engineers built structures of thin and rapidly-wasting steel, protected only by a quickly perishable wash of paint and called them permanent.

Perhaps such forecasts of the future as this may seem fanciful and far-fetched to some of our readers. If so we can only advise careful and unprejudiced study upon these topics. The engineer ought to work for the future as well as the present, and to do so intelligently he ought to form an intelligent opinion as to what the future will bring.

Of all the accumulated stores of Nature on which the world is making rapid inroads, that which is destined earliest to disappear is doubtless the timber supply. The need for husbanding this has long been urged, yet each year the lumberman's axe and the forest fire makes huge reductions in the area of forest still standing. Higher prices for all classes of timber and timber products are a certainty of the near future; and such prices, while they will scarcely diminish the consumption, will stimulate the lumberman to penetrate still more remote regions of forest. For the three hundred years since the settlement of America began, the work of removing the primeval forest has been in progress to supply the demands not only of America, but of Europe; and now the last and noblest of these forests, that on the Pacific coast, with its giants whose age is measured not in years, but in centuries, is rapidly being converted into timber and boards and shingles.

Mr. Henry Gannett, of the United States Geo-

logical Survey, as a result of careful studies of the timber resources of the United States, estimates that at the present rate of consumption, the available stock of timber on this continent will be exhausted in approximately a half-century.

When one considers the multitudinous uses to which timber is put, the outlook is serious enough. We can with advantage substitute some less perishable material in many places where timber is now used; but there are other places where it will be well-nigh impossible to find a satisfactory substitute. For example, what can the miner do without timber? How can mines be worked at all without timbers to support shafts and galleries and tunnels? Economy can, indeed, be practised here as in many other fields where timber is now wastefully used; but more or less timber appears to be absolutely necessary here, and indeed in nearly all classes of engineering work.

Fortunately, the world's timber supply is not like its store of minerals—absolutely irreplaceable when once used up. The forest can again be made to cover areas which have been denuded of trees and yet are not suitable for agriculture. By taking proper measures in season, new sources of timber supply may be made ready against the day when the old ones are used up.

It may be said, perhaps, that measures which look so far to the future are impracticable, under our present social organization. But is it not true that the extent to which provision is made for the future is a fair index of the progress of civilization? The barbarian literally took no thought for the morrow. He lived in alternations of plenty and starvation. The pastoral stage of civilization, with its flocks and herds, and the agricultural, with its reliance upon the soil for annual crops, followed in succession, each one marked by its greater provision for future needs. Finally, we have our present day modern life in which men strive to provide not only for the necessities of changing seasons, but for the time of old age and incompetence, and even for the later wants of children and children's children.

In the last analysis, legally as well as morally, public necessity has always a higher claim than any right of private property. It is entirely within the abilities of civilized governments to provide for such manifest necessities of the future as the conservation and perpetuation of the timber supply, the economical use and prevention of waste of the earth stores of petroleum, phosphorus, coal and any other products in which present consumption threatens to bring the world to an early famine. No rights of private ownership to use or waste at will are paramount to the public necessity.

It may be said that these are problems for the statesman rather than the engineer; but it is to the engineer and the scientist that the statesman will look for guidance upon these great questions. It is the engineers in the service of corporations whose future existence depends upon the supply of raw materials which the earth furnishes, who are most conversant with the diminishing supply and increasing demand and who can first foresee its results.

It will be apparent that in the above brief review we have only touched upon a few most important phases of a great world-problem. We have ventured no forecast at all, for example, of the conditions which will confront the race when the stored mineral riches of the earth are finally exhausted, and mankind is compelled to compass its wants by what the annual product of the soil will furnish. So many new and now unthought-of factors will then exist that the wisest can make no useful prophecy of human environment at that day.

In the review above we have confined our forecast only to the present century, a period of time no greater than the span of a human lifetime. This, surely, is not too far in the future for our present-day civilization to make provision. In commerce, in finance, in the field of statesmanship, it is not uncommon to look ahead as far as this.

The engineer, who has in the past utilized Nature's gifts for man's service, and whose pride it is to build for the future as well as the present, ought to foresee coming scarcity of these gifts, for it is to him that the world will look for a warning of scarcity and for guidance as to how future wants may be supplied.

LETTERS TO THE EDITOR.

Computing the Strength of an Iron Ring.

Sir: In reply to the inquiry of C. G., in your issue of Jan. 3, page 12, for a formula for the relation between the load W in pounds, and the maximum fiber stress f in pounds per square inch, in an iron ring of mean diameter D in inches and circular cross-section of diameter d in inches, I submit the following:

$$W = \frac{0.62\ d^3}{D}\ f \quad \text{or,} \quad W = \frac{1.57\ d^3}{d + 1.46\ D}\ f.$$

The first equation gives the relation between the weight and the maximum fiber stress at the point of application of W, and the second at the middle of either side of the ring. Use the smaller value of W.

For the analysis of a ring under such conditions, see the writer's "Structural Mechanics," page 235.

Chas. E. Greene.

Ann Arbor, Mich., Jan. 5, 1901.

"Earth" or "Dirt" Roads; Which?

Sir: I have been much interested in your recent articles on good roads and particularly that phase in which you insist that there are other good roads than those built of stone. The possibilities of earth roads have not only not been exhausted, but any other kind is financially out of the reach of the greater part of the country road mileage. A "campaign of education" is needed among highway commissioners and other local authorities in charge of country roads which shall demonstrate to them that it is not only possible but profitable for their roads to be maintained by scientific methods. By the way, why do you say dirt instead of earth roads; the dictionary definition of dirt is not only not descriptive but the definition of earth, from Webster, given below, could hardly be improved on by even the expert roadmaker: "Earth—the loose particles of inorganic matter on the surface of the globe in distinction from the firm, solid rock; soils of all kinds, including gravel, clay, loam and the like; sometimes, soil favorable to the growth of plant," etc. Dirt has its place in the world, I suppose, but it is hardly as a necessary component part of a well-kept earth road.

Yours truly, Eugene R. Smith.

Islip, Suffolk County, N. Y., Jan. 12, 1901.

(In reply to our correspondent's question we may say that of the several definitions of dirt and earth given by the Century Dictionary two are practically synonomous and are as follows: Dirt, earth, especially loose earth; disintegrated soil, as in gardens; hence any diluted or disintegrated material. Earth, the loose material of the earth's surface; the disintegrated particles of solid matter, in distinction from rock; more particularly, the combinations of particles constituting soil, mold or dirt as opposed to unmixed sand or clay. These synonomous meanings of dirt and earth are so familiar and commonly used in America that we might very reasonably reverse our correspondent's question and ask, why he says earth instead of dirt roads.—Ed.)

Pressures on Foundation Footings for Walls of Buildings.

Sir: While the formulas derived by Mr. Kemmler for finding the "Pressure on Foundation Footings," in your issue of Jan. 10, give correct results for maximum and minimum existing load per unit of area of base, the form

$$f = \frac{W}{b^2}\ (b \pm 6y)$$

is much simpler.

Here W is the load per foot of length of foundation footing; b is the breadth of the footing in feet; and y is the distance in feet that the resultant of the load passes to one side of the center of the footing. When the plus sign is used, f is the maximum pressure per square foot under the wall footing; when the minus sign is used, f is the minimum pressure. But if the latter result has the minus sign, indicating tension, which cannot exist under a footing course simply laid in contact with the foundation, the formula for maximum pressure is then

$$f = \frac{2\ W}{3\ (\frac{1}{2}\ b - y)};$$

and the pressure extends under that portion only of b given by the denominator. These formulas in a more general form, for rectangular or other bases, are derived and discussed in the writer's "Structural Mechanics," pp. 138-140.

Chas. E. Greene.

Ann Arbor, Mich., Jan. 12, 1901.

Sir: In your issue of Jan. 10 is published a little concerning the intensity of stress transmitted by foundation footings to the earth below. Mr. Kemmler's formulas are, no doubt, correct for certain cases, but I think that they may be questioned for such a case as cited in his second example, where the resultant pressure is applied outside the middle third of the footing. In this second example $x = 0.14$ W. Now the minus sign means a reversal in the kind of stress; that is, tension in the present case. The formulas would still hold if the joint in question were in masonry where the mortar may be depended upon to take this tension. But the discussion relates to a masonry wall standing on earth, and between them no tension would be developed.

A formula that covers all that is given by the formulas of your correspondent may be found, with its derivation, in Professor Baker's "Treatise on Masonry Construction," under Masonry Dams. It is as follows: $P = \frac{W}{l} + \frac{6\ W\ d}{l^2}$, in which P = the greatest intensity of compressive stress, W = total normal pressure, l = length of joint, and d = distance from the center of pressure, W, to the middle of the joint. All this is for unit length of wall. If d is greater than $\frac{1}{6}$ tension is developed on one side of the joint, and its greatest intensity is $P - \frac{2\ W}{l}$. If the joint is not capable of resisting tension the following formula, also from Prof. Baker, will serve:

$$P = \frac{2\ W}{3\ \frac{1}{2} - d}.$$

By this formula your correspondent will have in his second example $x + y = 0.67$ W instead of 0.34 W.

Respectfully, Frank T. Daniels.

Pemberton Building, Boston, Mass., Jan. 14, 1901.

The Computation of Economic Overhaul.

Sir: It sometimes becomes necessary in computing overhaul, to find the point from which a cut will haul most economically in both directions. If the cut and the fills at each end were symmetrical within the limit of haul, the solution would obviously be to haul half of the cut each way. But as it often happens that the cut is deeper at one end than at the other, and the fills also are of different heights the general solution is slightly different.

The most economical haul is that in which the sum of the overhaul in both directions is a minimum. To satisfy this condition the proper location of the point of division is such that the extreme haul in each direction is the same. The method of finding this point is easy enough, being a simple problem in arithmetic, and does not need description. The method by which the writer arrived at the rule given is also immaterial; it is only necessary to demonstrate the correctness of the rule.

In the figure, which may represent the profile of a cut *D* E and the fill at each end, let

Σ H = overhaul from B to A;
Σ H′ = overhaul from B to C;
A B = B C = L.

Σ (H + H′) is now a minimum; for, move the point of division a short distance, a to B′, and let the excavation prism from B to B′ = Q. The quantities from B′ to D will now haul to A′, a distance m a from A, and the overhaul from B′ to A′ will equal

$$\Sigma\ H_1 = \Sigma\ H + Q\left[L + \frac{a + m\ a}{2}\right],$$

a and m a being so small that the center of gravity of Q is in the center of the prism.

Similarly, the quantities from B′ to E will now haul to C′, a distance n a from C, and the overhaul from B′ to C′ will equal

$$\Sigma\ H_1' = \Sigma\ H' - Q\left[L - \frac{a + n\ a}{2}\right];$$

$$\Sigma\ (H_1 + H_1')$$
$$= \Sigma H + \Sigma H' + Q\left\{\left[L + \frac{a + m\ a}{2}\right] - \left[L - \frac{a + n\ a}{2}\right]\right\};$$
$$= \Sigma\ (H + H') + \frac{Q\ a}{2}\ (2 + m + n)$$

which is greater than Σ (H + H′).

Yours truly, Geo. H. Tinker,
Div. Engr., B. & M. R. R. R.

Huntley, Mont., Dec. 29, 1900.

Impact Tests of Iron and Steel at Purdue University.

Sir: I would like to refer to an observation in your editorial comment on Impact Tests, in the issue of Jan. 3, 1901. The statement is there made that the resilience of Norway iron as found by the machine used by Mr. S. Bent Russell was about the same as that found for mild steel in the machine devised by Mr. W. P. Turner and the present writer. It should be noted that just as there is only a direct comparison of the per cent. of elongation at rupture when there is an equality between the gage-length of the bars compared, so too (on account of the

disproportionate work done in stretching the material of the neck) there is only a direct comparison between the total resilience of two test bars when the gage-lengths are equal. Since the gage-length of Mr. Russell's bar of wrought iron was 1 in., and the gage-length of the writer's bar of mild steel was 8 ins., the direct comparison of the two is misleading. If Mr. Russell's tests had been made on longer bars the measured resilience would have been less. As the resilience was also less for the nicked section, it appears that Mr. Russell used that length of bar near the length for maximum resilience.

The writer records in Table I. some of the values reached in tension impact tests at Purdue University. Formerly the writer arranged his tests to obtain a complete comparison between the results of slow tension and impact tests. Indeed, he obtained, three years ago,* measurements similar to those reported by Mr. Russell, and also, for rods 10 ft. long, a stress-strain diagram under impact in tension. At present, however, he only makes use of the slow tension test to describe the quality of the material used in the impact investigation. The endeavor to compare the resilience under slow and impact tests is, in the writer's opinion, like the endeavor to measure the "pressure due to a blow" attended with results of little value.†

The character of the static and impact test being fundamentally different, the writer believes that the impact test for metals, like the rattler test for brick, must stand on its merits, and the technique thereof will be largely determined without reference to the static test. The form of test bar, for instance, is to be determined, not necessarily by comparison with the results of the static test, but by measurements, under the conditions of impact, of the effect on the results of variations in size and conditions of test bar; the effect of the distance from the gage marks, etc. Matters relating to the variation of temperature, of speed of delivery of a given amount of energy, the proper number of blows, are proper and urgent objects of inquiry.

It is quite possible, for instance, that the shock resisting capacity of a metal or the prejudicial effect thereon of certain chemical elements, or of certain methods of manufacture, may best be determined by the nicked bar of Mr. Russell's test. The fact that we cannot compare the result of tests on this form of bar, with the result of static tests on this or any other form should not prejudice the discussion. Yet it will doubtless seem reasonable to most to suppose that the present form of the static tension bar which embodies the result of extensive experience will also best serve for tension impact tests. Again, the fact that the tension test seems to be a most convenient and valuable form of slow test may lead us to attempt to overcome the mechanical difficulties inherent in the impact tension test, although a larger measure of success would attend the use of the flexural or some other form of impact test. Perhaps the above remarks may not be amiss in view of the danger of keeping too close to the circumstances of the slow test in outlining experimentation in impact.

While these remarks have drifted somewhat beyond the editorial comment referred to in the beginning of this letter the writer returns to that comment in suggesting that it might prove misleading in still another way. It might lead some to infer that there was in general a greater amount of resilience developed in an impact test of a ductile material than in a gradual test. It is especially dangerous in the present state of knowledge of impact tests to go much beyond the experimental facts. Materials which under the conditions of static tests show only slight differences of behavior, show great differences of behavior under impact. For instance, in case of soft steel and copper the upsetting effect of one heavy blow is greater than that of a number of light blows of the same total energy. Yet in case of lead the facts are just the reverse. And while accepting* as correct the indications of increased resilience under impact developed in Mr. Russell's tests on bars of 1-in. gage-length, in which the distortion of the neck plays an important part in the resilience, it should be noted that no such increase may be expected in case of longer bars. The evidence which we have at present, as far as the writer knows, points to the fact that for tests bars of ductile material of size corresponding to or greater than those commonly used in slow tension tests, the results of the impact test are not decidedly different from those of the slow test as regards the elongation, contraction or resilience. This statement probably does not hold for harder steels or for defective material.

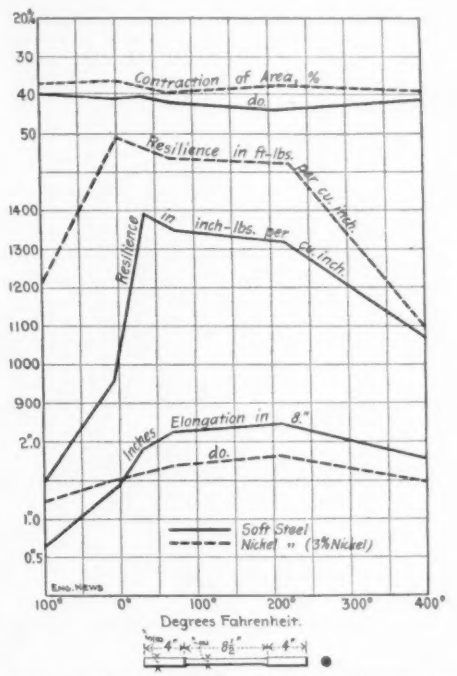


Fig. 1.—Diagram Showing Effect of Temperature on Resilience, Elongation and Contraction of Area of Soft and Nickel Steels Tested by Impact. (Each point is the average of three or more tests.)

The writer may, perhaps, be pardoned for here outlining the work accomplished at Purdue University in the field of impact tension tests and for sending the results of part of the work (in Table I. and Fig. 1), which, with other developments, will shortly form the subject matter of a long delayed communication to another source of publication. This work has extended over a period of three years. The first year measurements were made of the resilience in slow and impact tension tests. Stress-strain diagrams were developed for long rods of Norway iron and steel wire. During the following year investigations were continued to include steel wire of various lengths, hardness, and temperature. Last year, on the new machine, bars of nickel steel, and machine steel, were broken at temperatures ranging from — 100° F. to + 400° F. The effect of different lengths of specimens was investigated. During the present year, cast iron, cast steel and concrete are under examination.

Fig. 1 is a graphical representation of the results obtained in impact tension tests, on nickel steel and machine steel, at different temperatures. A curious effect was noticed in a test (under two blows) of an unturned bar of steel, which had been frozen along the middle third of its length in a bath of ether and carbonic-acid snow. The middle third of the length preserved its original diameter, and, as the scale had not been broken, the yield point had not been exceeded. The ends, however, had been drawn down to necks. The frozen length had thus been converted practically to a harder and more elastic steel which transferred the energy of the blow to the softer and warmer parts; just as the hard face of an armor-plate quickly transfers without itself suffering excessive deformation, the energy of the shot to the soft back, where this energy is taken up. Of course the total resilience of this partly frozen bar is less than that of the wholly warm bar. If this one bar may be taken as an index of what happens in general, and what has happened in three or four cases in the writer's experience, we may believe that a locomotive connecting rod is stronger to resist the shocks of ordinary service in winter than it is in summer. But of course in case the necessity arose to take up unusual and undesigned-for shocks, the rod will break more easily in winter.

I hope these rambling observations, which are the result of reading Mr. S. Bent Russell's valuable communication and your interesting editorial comment, will be of value to some of the readers. Yours truly,

Purdue University, Lafayette, Ind., Jan. 8, 1901. W. K. Hatt.

*For reference to this work see Eng. News, Vol. 40, p. 148; Bulletin No. 5, American Section, International Soc. for Testing Materials. As the results of the tests of impact resilience of steel made at Purdue University were partly reported to the International Congress at Paris in July, 1901, this public record of the measurement of impact resilience in tension antedates the measurements reported in Eng. News, Jan. 3, 1901.

†Lieut. Dunn (Journal Franklin Institute, Vol. 144, p. 321), has solved the problem of the pressure due to a blow and measured also the impact resilience of copper under compression. His delicate measurements are of scientific interest. The crude methods of obtaining the "pressure of a blow" in tests of draft rigging and other railway structures, with the desire to compare the severity of this test with the severity of a static test, are the result of a misconception of the nature of the impact test.

*The writer notices that in Table III. of Mr. Russell's tests the elongation was greater under slow tests whereas the resilience was in excess under impact tests; and, as he has become accustomed to expect a large increase in the resilience in case of long bars of ductile material, to be accompanied by a large increase in the elongation this greater resilience reported in Table III. seems an anomaly.

TABLE I.—Results of Tension Tests under Gradual and Impact Loading; Purdue University.

Material.	Material: Length, ins.	Material: Diameter, ins.	In lbs. per sq. in.: Ultimate strength.	In lbs. per sq. in.: Elastic limit.	Resilience, ft.-lbs. per cu. in.	Elongation in % of entire length.	Contraction of area in per cent.	No. of test.	
Steel wire	72	0.3	72,000	30,000	732	14.1	63.7	5	Gradual.
	108	0.3	72,000	30,000	854—688	15.6—12.0	65—59	6	Impact.
Steel wire	48	0.16	83,000	45,000	555	8.6	50.7	1	Gradual.
	48	0.16	83,000	45,000	760—600	11.0— 8.7	57—33	5	Impact.
Steel wire	108	0.26	109,000	60,000	351	4.0	50.0	2	Gradual.
	108	0.26	109,000	60,000	700—540	6.7— 4.3	54—20	20	Impact.
Steel wire	48	0.16	115,000	80,000	135	0.26	5.0	2	Gradual.
	48	0.16	115,000	80,000	208—165	1.0— 0.42	41—16	4	Impact.
Norway iron	72	0.31	48,000	31,000	658	18.1	72	3	Gradual.
	108	0.31	48,000	31,000	658	18.5—12.0	72—65	3	Impact.
Steel (machine)	8	0.5	68,400	49,600	1,370	24	41	7	Gradual.
	8	0.5	68,400	49,600	1,358	27	42	13	Impact.
	8	0.5	Bar No. 4.....		1,362	22	41	2	Gradual.
3.15% nickel steel..	8	0.5	" " 4.....		2,144	25	39	2	Impact.
	8	0.5	" " 2.....		1,600	23	..	4	Gradual.
	8	0 5	91,270	57,270	.....	26.7	63	Mill test.	

Note.—Results of temperature tests on the machine steel and nickel steel (except Bar 4) are shown in Fig. 1. Static resilience under gradual test measured with Henning Recorder.

Notes and Queries.

If "A. L. S.," of Urbana, O., will supply us with his full name, consideration will be given to his inquiry of Jan. 14, 1901.

The 95th St. bascule bridge at Chicago, the competitive designs for which were given in our issue of Jan. 10, will differ somewhat from the general design of the accepted plan as illustrated. The bridge is being built to the designs prepared by Roemheld & Gallery, who are the contractors for the substructure and the superstructure. The trusses are almost identical with those shown, except that they are 30 ft. longer and all the heel members are inclined. Instead of a plate girder span carrying the trunion bearings there will be a steel framework. The substructure will consist of two separate piers connected by three separate tail pockets, one for each truss, and the bottom of these will be formed by a thin sheet of concrete with rods and wire netting embedded in it, the space under this serving as a by-pass. The operating machinery is composed of a single train of gears actuated by one 75-HP. motor, instead of by two trains of gears and two motors, as described. Our article stated that the plans shown had been modified.

GARBAGE DISPOSAL AT INDIANAPOLIS, IND.

Previous to the spring of 1893, each householder at Indianapolis disposed of his garbage as suited him best, provided he made no nuisance. Generally the kitchen refuse was collected by persons who used it to feed hogs, or for other purposes. One person usually got the garbage of a number of householders. The hotels disposed of their garbage generally at a profit to the same person. The garbage from the hotels, restaurants and wealthier householders, being richer than that of the poor people, these private collectors chose it to the neglect of that of the poor people. The poor people, therefore, got rid of the garbage by throwing it into their privy vaults, burning it in the kitchen stove or burying it. The system was very unsatisfactory.

In 1893, two contracts were made by the city of Indianapolis, one for the disposal of the garbage and other wastes and another for the collection of garbage. The contractor for the collection of garbage was Mr. J. H. Woodard, who was to look to householders and others for his pay, which was fixed in the contract at the rate of 0.249 cts. per lb. The Indianapolis Desiccating Co. received the contract for destroying garbage, offal and other waste material, running for ten years, commencing May 26, 1893, and ending Jan 1, 1903, at the price of $10,000 a year.

The company which had the hauling contract was to deliver garbage to the plant of the other company, and the latter was also to receive night soil, refuse and unclean material, other than gar-

bage. This contract was, however, modified by the removal of the plant of the Indianapolis Desiccating Co. from the city of Indianapolis to the Sellers Farm, which is about four miles from the city, where all the garbage, night soil and unclean material is taken care of by the above-named company.

The citizens of Indianapolis refused to pay the 0.249 cts. per lb. for the collection, provided in the contract, and the large hotels and restaurants and the richer people, not only had previously been getting rid of their garbage free of charge, but in many cases were paid for the same. They positively refused to pay others for the collection of their garbage, when parties stood ready to pay them for the privilege of removing it. The poorer classes simply continued to dispose of their garbage in the old way, and stated when the collector came around to collect the garbage, that they had none for him. The collector, himself, did not carry out the contract to the letter, and in many respects avoided, when possible, taking garbage in small quantities from the poorer people where it only amounted to a market basket or a box full. There was not enough in it for him. Therefore, he collected from the large producers and neglected to collect from the small ones. Finally, some of the hotels combined to fight against paying for the collection of garbage, as required by the contract, and in a decision of the court, it was held that they could not be forced to pay. This made the contract with the collector valueless, and to save any trouble with him, the city paid him a small amount to release it from the contract, and it was cancelled in 1894.

During the year of 1895, the city nearly concluded a contract for garbage collection and disposal with the Consolidated American Reduction Co., of New York city, but it experienced much difficulty when it attempted to close the contract, and finally abandoned the attempt, as was also the case with a number of other cities that tried to do business with this company.

At Indianapolis there was first a story that this company would treat the garbage without charge, for the sake of its products. Finally, a contract was drawn, providing for the collection of garbage and night soil at $12,000 a year. The local agent for the company signed this contract, but the Board of Public Works delayed its signature for some weeks, and then the company after further investigation refused to sign the contract, unless the price was raised to about $20,000 per year.

After the experience just outlined, the matter of garbage collection seems to have been in abeyance for a year or two.

In May, 1897, the city received bids for the collection of garbage for a period of 10 years. The competitors made offers ranging from $307,980 to $373,947 for this period. The lowest bid was submitted by Mr. John R. McCarthy, of St. Louis, said to have been backed by Mr. Edward Butler, of that city. Under the contract awarded to Mr. McCarthy, he agreed to collect not only the garbage, but the miscellaneous dry refuse in addition. The contract prices by years are as follows: Half of 1897, $15,000; 1898 to 1901, inclusive, $29,995; 1902 to 1904, $31,000; 1905 and 1906, $32,000; half of 1907, $16,000. Average price per year, $30,758.

This company also had a great deal of trouble with the city of Indianapolis in making the collections, and in 1897 it assigned the contract to the Indianapolis Sanitary Co., a corporation, which began business in that year with a capital stock of $50,000. The principal men in this company were also largely interested in the Indianapolis Desiccating Co., which held a contract for the disposal of the materials just mentioned.

The new company substituted wagons with removable steel boxes for the old dump wagons, formerly used. It built a switch, about a mile in length, to the reduction works, and also built a large transfer house in the city for the purpose of loading the steel wagon boxes on railway cars for transportation to its reduction works, located four miles from the city. At that time the company was cremating all garbage and night soil and refuse matter of all kinds. A Bulfinger furnace was used for this purpose. The furnace was put in operation in 1893 and garbage was burned from that time until 1898. It is now used for the disposition of the residue from the treatment of night soil.

In 1898 the Indianapolis Sanitary Co. put a new system in operation, under the methods controlled by Mr. M. H. Chamberlain, of the Detroit Sanitary Co., Detroit, Mich. In May, 1899, the plant was seriously damaged by fire. A new plant was at once constructed, and, the company states, is now running very satisfactorily.

The garbage is collected in steel boxes, taken to the transfer station, hoisted on flat cars, especially made for this purpose, holding from 17 to 20 boxes, and transported to the reduction plant at the Sellers Farm. A steam hoist and carrier takes a steel box from the flat car, hoists it up, carries it into the building, where it is dumped on a water-tight floor. Here tin cans and all foreign matter are taken out. The garbage is then put in iron digesters, of which there are at present ten in number. These digesters are made of ⅝-in. steel plates, 5 ft. in diameter and 14 ft. high. The tanks are similar to those used in Detroit, Cleveland and Columbus. The garbage and dead animals are cooked under 60 to 80 lbs. steam pressure. After being subjected to this cooking process for five or six hours, the tankage is pressed in the tanks from three to four hours, making eight to ten hours in all for each charge. More cooking is required in summer than in winter. After pressing, the steam is turned off the tank, the tankage is taken out and goes directly into an Anderson dryer. From there, the tankage is put into cars and transported to the large fertilizer establishment of E. Rauh & Sons, and is used in their works in making fertilizers. Five boilers of 80 HP. are also in use. The gases are passed through an Anderson deodorizer. The building that contains the Anderson drier is separate from the tank building, and is of brick, as is also the boiler and engine house.

The Indianapolis Desiccating Co. is also responsible for the destruction of night soil, which is delivered to it by private parties, householders paying for collection and hauling. The night soil is brought to the plant in air-tight barrels and then screened by passing it through slats placed over a box. The matter thus retained is scraped off and cremated. The liquid is run into a second box, where it is "cooked with steam" and then discharged through a sewer into a stream near by.

The total amount of refuse treated in 1900, including everything, was 25,000 tons.

The officers of the Indianapolis Desiccating Co. are: Mr. F. M. Bachman, President; Mr. August Elbrecht, Secretary and Treasurer, and Mr. W. B. Geyer, Superintendent. We are indebted to the company for the revision of our historical sketch of garbage disposal in Indianapolis and of our description of the present reduction works. The original draft of the article was prepared largely from city reports of Indianapolis and from notes taken at the disposal works in September, 1900, by a member of the editorial staff of this journal. The revision by the company brings the descriptive matter down to the close of 1900. We are also indebted to Mr. C. H. Spencer, Secretary of the Board of Public Works, for courtesies extended during the preparation of this article.

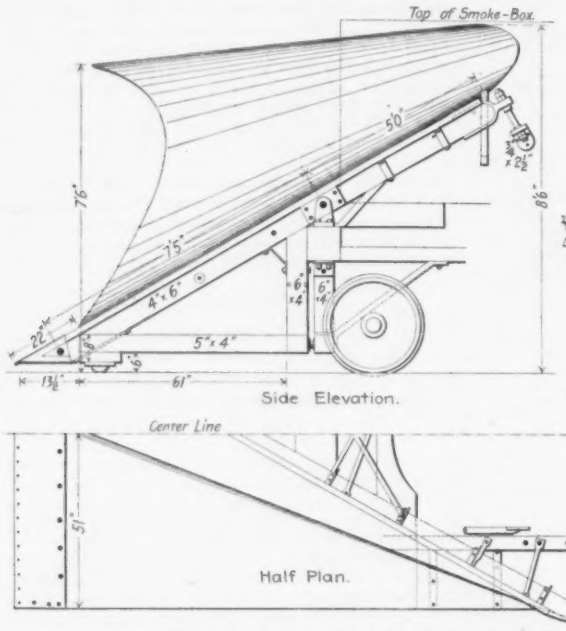


FIG. 1.—SNOW PLOW FOR LOCOMOTIVE; WISCONSIN CENTRAL RY.
Angus Brown, Superintendent of Motive Power and Cars.

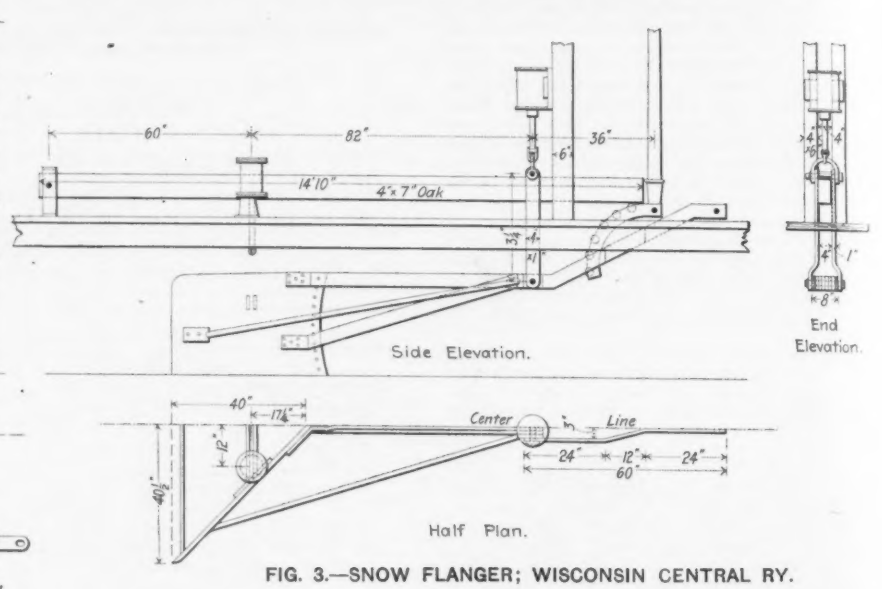


FIG. 3.—SNOW FLANGER; WISCONSIN CENTRAL RY.

THE USE OF SNOW PLOWS AND FLANGERS.

With the approach of the winter season, railways in regions where snowfalls are to be expected have to begin to make preparations for keeping the line open or for clearing it when traffic has been blockaded by a heavy storm. The extent of the trouble experienced depends not only upon the depth of the snow, but upon the character of the road. Prairie lines which are built almost on the surface of the ground are soon covered with drifts, while if carried on even a low bank the snow will drift up on the sides, leaving the track open for a considerable time. Narrow cuts with steep slopes are also a source of great trouble. Snowsheds are now rarely employed in

level country, and some of those on the Intercolonial Ry. have been removed, and snow fences substituted. Early in the season, all permanent snow fences should be repaired and braced, and portable fences erected where experience shows that they are needed. On some roads, also, the signs indicating where flangers must be raised to clear frogs, crossings, etc., are erected at the same time, these signs being taken down in the spring and stored until again needed. In a report presented at the recent meeting of the Eastern Maintenance of Way Association, it was shown that when the road is opened after a snowfall, there is often much trouble, particularly in level countries, by the wind causing shallow drifts to form over the rails, which will cause trains to lose time

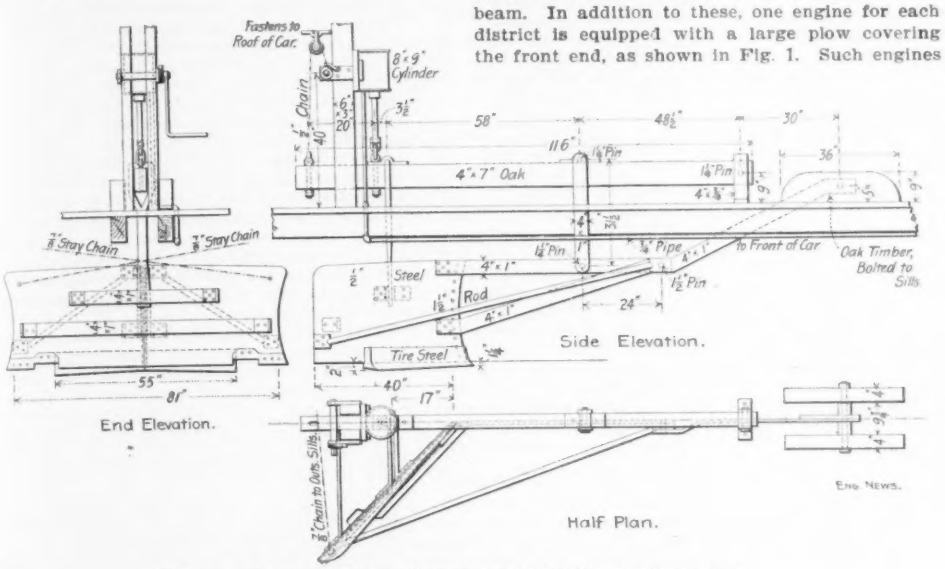


FIG. 2.—ELLIS SNOW FLANGER; WISCONSIN CENTRAL RY.

or reduce the number of cars hauled, the result in either case being expense and delay. In such cases a flanger attached to the engine and operated from the cab, or attached to a box car and drawn in the train, serves a useful purpose.

This brings us to another point to be considered, namely, that of preparing the rolling stock to deal with the drifts which will occur in spite of any fences. The methods employed will vary, of course, on different parts of a railway. On the Chicago, Burlington & Quincy R. R., strips of wood are nailed in between the bars of the pilot, so as to form a smooth and solid surface, while on some branch lines the engines are equipped with small sheet-iron pilot plows. On a few divisions of the road, large engine plows are used, being attached to the locomotive and extending above the boiler. On the lines of the Chicago, Milwaukee & St. Paul Ry., in the peninsula of Michigan and in the extreme northern part of Wisconsin, it is the practice to use for ordinary storms, pilot snow plows and flangers attached direct to engines. In most of the territory, however, the work of plowing snow is done with the independent plow and independent flanger. In the latter case the large engine snow plow reaching well up above the top of the boiler is used. The flanger is attached to an independent car. The snow plows and flangers are of the ordinary type quite generally in use for a number of years. This road has also two rotary plows, located in Minnesota. These are not often used, and it has happened that for two or three years at a time the plows were not in service, but in extremely heavy storms where the snow drifts 10 and 15 ft. high the rotary plows are very necessary.

The Great Northern Ry., which passes through a region of heavy snowfall, does not use pilot plows on the engines. A few flanging cars are used, and a large number of iron engine plows which are fastened to the pilot beams, the pilot being removed. This road also has some rotary plows, and in order to keep the snow well back from the track "snow dosers" are employed. These are large wings fastened to cars and extended so as to spread the snow back before it becomes too deep. Many roads use flanging cars to clear the rails, and these are often fitted with side wings for spreading the snow or for widening the cut made by a snow plow. Where large breaking or push plows are used to open up drifts, they should always be equipped with flangers, so as to give a clear rail for the engines which are pushing the plow. The methods of operating snow plows and snow cleaning forces in heavy work on the Colorado Midland Ry. were described in our issue of Aug. 23, 1900.

The Wisconsin Central Ry. equips all its passenger engines and about 25% of its freight engines with pilot plows. These plows reach to the top of the front bumper timber and are rigidly bolted to the pilot foundation and secured by means of braces to the ends of the pilot bumper beam. In addition to these, one engine for each district is equipped with a large plow covering the front end, as shown in Fig. 1. Such engines are held for any emergency that may arise as the result of heavy snowfall and wind storms which may pile up the snow beyond the capacity of the smaller pilot plows referred to. For flanging, this road uses the Temple flanger, hinged to the forward end of the pilot and operated by means of air taken from the main reservoir and under control of the engineman in the cab. In addition to the Temple flanger, there are also a number of box cars equipped with a more substantial flanging device suspended midway beneath the trucks. This, as shown in Fig. 2, is also raised and lowered by means of air, and is under control from the engine which handles the flanger. Another very similar flanger, Fig. 3, has the beam pivoted behind instead of in front of the flanging-blades, and has two air cylinders. One has its rod connected directly to the flanger, while the other is attached to the horizontal bar carrying the flanger.

Engine plows usually conform to the outline of the pilot, but some of those of the Chicago & Northwestern Ry. have the iron plate extended above and beyond the top corners of the pilot and bumper beam, so as to throw the snow away from the engine and from the track.

The use of pilot and engine plows and flanging cars will aid very materially in keeping the road open and preventing delays due to light snow on the rails. For heavy work, however, a regular breaking plow, driven by one or more locomotives must be employed. These plows should be fitted with air brakes operated from the head engine, and should have some means of communication by which the man on the look-out of the plow can promptly warn the engineman to stop in case of emergency. Sometimes this is effected by a cord from the plow to the engine whistle, but it has happened that the man on the plow has tried to signal the engineman just when the latter was sounding the whistle for a station. Ordinarily, the side wings of the plow may be extended to make a wide cut, but in deep or wet snow it may not be possible to do this. The plow must then be run through first with wings closed, and then again with one or both wings extended to widen the cut already made.

DUTY TESTS OF WORTHINGTON PUMPING ENGINES; RIDGEWOOD PUMPING STATION, BROOKLYN, N. Y.

The recent tests of the three new Worthington triple expansion, vertical, high duty pumping engines installed about a year ago in the new Ridgewood Pumping Station of the Brooklyn, N. Y., water-works, developed the very excellent duty record of over 132,000,000 ft.-lbs. per 1,000 lbs. of steam. Compared with the very high duties given by the engines whose tests were discussed in our issue of Sept. 27, this performance is not especially notable, but it is, we think, the highest record ever obtained from pumping engines of the make and type described. According to the contract under which the engines were installed, each was to be of not less than 20,000,000 gallons daily capacity under ordinary working conditions, while delivering the water into the reservoir through the regular force mains, and each was then to have a minimum duty of 125,000,000 ft.-lbs. of work per 1,000 lbs. of commercially-dry steam, with a steam pressure not to exceed 135 lbs. per sq. in. Each engine was also to be capable of increasing this capacity to 22,500,000 gallons, without undue strain, and with a smooth and quiet action, at a piston speed not greater than 225 ft. per minute. For every million gallons which the actual capacity exceeded the requirements the builders were to receive a bonus of $1,000.

Summarized briefly, the results of the tests showed the following duties and capacities of each engine, and also the following bonuses due to the builders:

	No. 1.	No. 2.	No. 3.
Duty, ft.-lbs.	132,140,467	131,971,425	134,394,383
Capacity, per 24 hours:			
Normal speed, galls	21,035,994	20,945,252	21,041,326
Excess speed, galls.	22,957,795	22,746,718	22,655,656
Bonus to contractor	$7,140	$6,971	$9,394

In making the tests all three engines were run continuously for ten days under the ordinary conditions of the pumping station as regards regular attendants and the delivery of the water to the reservoir. The weight of the water delivered into the reservoir by the pumping engines, in estimating the duty and the corresponding quantity representing the capacity were determined by weir measurement. The percentage of slip in the pump was determined by subtracting the amount of water which passed over the weir from the corresponding plunger displacement, and upon these net amounts the capacities and duties were computed. The following table gives some of the more important results recorded in the detailed log of the tests. The tests were conducted by Messrs. Henry G. Morris, J. E. Denton and Charles A. Hague, Mems. Am. Soc. M. E. We are indebted to Mr. Hague for the records of the test from which this abstract of the results has been made.

Duty Tests of Three Pumping Engines Made at Ridgewood Pumping Station, Brooklyn, N. Y.

	Average steam pressure, lbs.	Plunger- Total head, lbs.	Plunger- Average travel, ft. per min.	Displacement, gallons pr 24 hrs.	Percentage of slip by weir test.	Gallons delivered per 24 hrs.	Duty per 1,000 lbs. steam- Plunger displacement.	Duty per 1,000 lbs. steam- Weir measurement.
Engine No. 1:								
Contract duty	129.54	76.962	164	21,433,824	1.64	21,082,309	134,343,704	132,140,467
Normal capacity	129.9	76.976	163.65	21,386,736	1.64	21,035,994	.....	.....
Excess capacity	131	78.359	180.53	23,594,856	2.70	22,957,975	.....	.....
Engine No. 2:								
Contract duty	130.36	81.250	164.09	21,432,528	2.09	20,984,588	134,788,505	131,971,425
Normal capacity	130	80.926	163.6	21,392,352	2.09	20,945,252	.....	.....
Excess capacity	130.64	82.157	180.6	23,576,400	3.53	22,746,718	.....	.....
Engine No. 3:								
Contract duty	133.32	83.19	165.57	21,599,016	2.58	21,041,762	137,953,585	134,394,383
Normal capacity	133.58	83.186	165.56	21,598,569	2.58	21,041,326	.....	.....
Excess capacity	134.3	85.705	178.64	23,306,187	2.72	22,655,656	.....	.....

THE COST OF WAGON TRANSPORTATION AND OF THE MAINTENANCE OF EARTH ROADS.

The question of road improvement, in its various relations, received a considerable share of attention at the annual meeting of the Illinois Society of Engineers and Surveyors at Bloomington, Ill., Jan 23 to 25. Among the most important papers on this subject were two by Prof. I. O. Baker, M. Am. Soc. C. E., of the University of Illinois, whose analysis of the relation of road improvement to the financial conditions of the farming community has recently been given in our columns. As both of these papers deal with actual conditions and prices, we give below full abstracts:

COST OF WAGON TRANSPORTATION.

One of the advantages of any proposed road improvement is the decreased cost of transportation, but reliable data as to the economy of improved roads is lamentably scarce. It is the purpose of this paper to inquire into the cost of wagon transportation with a view of securing data to be used in determining the possible saving to be derived from any proposed road improvement.

In the first place a distinction must be made between work done by those whose chief purpose is transportation and that done by those to whom transportation is a mere incident of a business organized for a different purpose. The first class of workers is represented by the man whose sole business is to sell transportation, and the second is represented by the farmer whose business is organized to produce farm products, the transportation of which to market is ordinarily a very small part of his business. For brevity, the first class will be referred to as freighters and the second as farmers.

The cost of transportation is more to the freighter than to the farmer. In the first place, feed, barn rent, and usually labor costs the farmer less than the freighter. For three months of the year it costs many farmers absolutely nothing to feed their teams. In the second place, the freight carried by the freighter must pay a share of the expense incurred while the team is idle, while the hauling done by the farmer is done usually during periods of idleness either comparative or absolute in his chief business. Farther, the power employed by farmers in transportation costs practically nothing, since more horses are required to cultivate the crops than to transport them to market. This may not be true of dairymen and gardeners, but they are not representative farmers, since, according to the U. S. Census, dairymen, gardeners, vinegrowers, florists, and nurserymen constitute only 1-57th of the so-called farming class. Again, when the farmer uses his teams in transportation, it is unnecessary to feed them as heavily as does the freighter, since the service is comparatively brief. There are a few minor differences in the same line that need not be discussed here.

In discussing the cost of wagon transportation in reference to road improvement, consideration should be given only to hauling in which the load is equal to the full capacity of the team for the particular condition of the roads. A farmer may employ a two-horse team to take a bushel of potatoes to town, or a grocery wagon may make a trip to deliver a pound of cheese, but the partial load is entirely independent of the condition of the roads. Farther, it is necesary to notice that only the rate for wagon loads should be considered. If a number of packages are carried in the same load for different parties, part of the charge is to cover the cost of collection, distribution, possible partial loads, etc., and therefore only part of the charge is for transportation proper. Most of the hauling upon the country roads is done by the farmers; but the cost to freighters will be considered first to throw light upon the cost of wagon transportation to farmers.

COST TO FREIGHTERS.—The following data are all that are readily obtainable concerning the actual cost of wagon transportation to freighters:

1. Some years ago, San Francisco merchants, because of excessive railway freight rates, shipped goods by wagon from Stockton up the San Joaquin valley to Fresno, a distance of 146 miles, at 3.5 cts. per ton-mile. Presumably the road was unimproved, although in a good condition for one of that class. The price is surprisingly small, probably due in part to a return load. This example is hardly representative of ordinary transportation on the wagon roads, owing to the long distance and large loads.

2. The author is informed that in the mountain region of the northwest the usual rate is 1 ct. per 100 lbs. per mile, which is equivalent to 20 cts. per ton-mile. This rate obtains between Red Rock, Mont., and Salmon City, Idaho, a distance of 70 miles over the continental divide, one of the termini being 1,500 to 2,000 ft. below the summit and the other 3,000 ft. The road was unimproved, with a considerable intermediate rise and fall. This example is not representative of the average hauling on country roads, because of the long haul and the rise and fall.

3. In Engineering News of Jan. 16, 1896 (page 4), are a few meager details showing that wagon transportation in 1877 in connection with the construction of the Boston Water-Works, cost 12 cts. per ton-mile. It is stated that the "roads were good, and were probably better than the average country roads." It is also stated that the "compensation was hardly considered fair."

4. For several years the University of Illinois paid 30 cts. per ton for hauling coal. The haul was almost exactly 1 mile, and therefore the cost was 30 cts. per ton-mile. The coal was used for heating, and therefore the work was done chiefly during the winter months. The storage capacity was sufficient for 20 to 30 days' consumption, and consequently there was a little latitude in choosing the time of delivery. The roads were practically level and the surface was loam, and frequently almost impassable, sometimes four horses being able to haul only one ton. This is an example of the cost in winter, when the roads are in their worst condition, and in a locality where they probably get as bad as anywhere.

5. Later, when the consumption of coal at the university had greatly increased, and the streets had been paved nearly all the way, the price was 20 cts. per ton for a haul of 1 mile, which price prevailed for three years. The contractor thought he barely made expenses, chiefly because the unpaved roads were very muddy. Then for one year the price was 19 cts. per ton for 0.75 mile, or 25.3 cts. per ton-mile. This haul was entirely on brick pavements. Apparently the contractor lost money, owing chiefly to the difficulty of getting cars switched promptly. The next year, when the annual consumption was 5,000 tons, the price by a different bidder was 20 cts., with the expectation of hauling the same distance, but the coal arrived by a different railway, thus making the haul 1.5 miles, and therefore the price was 13⅓ cts. per ton-mile. This also was upon brick pavements. The men load, haul and unload, five loads of 3 tons each day for a day's work, an equivalent of 22.5 ton-miles per day, some of the men completing the stint in eight hours. According to the estimate of the writer, the contractor, after paying for labor, feed, barn rent, interest, maintenance, and depreciation, has 10% to pay for superintendence and contingencies. The contractor looks after the work closely, and while not making any fabulous sum is satisfied with his contract. The last item is an example of the cost of transportation under the most favorable conditions for freighters.

6. For several years large quantities of sand and gravel have been delivered a distance of two miles, over level loam roads, during the building season, by contract, for 20 cts. per ton-mile, including loading and usually unloading with shovel. In the same locality for a number of years, large quantities of clay have been delivered to a brick and tile yard, during the working season, at 20 cts. per ton-mile, including loading with shovel. Brick are loaded and hauled and unloaded for substantially the same price. These items are examples of the cost during the summer when the earth roads are in their best condition.

COST TO FARMERS.—Non-resident land owners in central Illinois frequently hire corn delivered for 9 to 11 cts. per ton-mile. This price has obtained over large areas for 10 or 15 years. The contract is usually taken by the man who does the shelling, he hiring farmers to do the hauling. The author knows of these prices being obtained frequently during the corn-planting season, when the farmers are most busy and when the roads are certainly not at their best. Many times farmers haul corn to the farther market for a slight difference in price, the difference in price being equivalent to 6 to 9 cts. per ton-mile for the hauling. The lower of these prices usually obtains when the roads are good in the winter season, while there is little or no farm work to do.

The Standard Oil Co. has a number of distributing points in Illinois from which it delivers kerosene, etc., to the neighboring towns with tank wagons. These distributing points are so numerous as to practically cover the entire state, and the same system is used in at least several other states. The company owns its own teams and wagons. In central Illinois it delivers its products 20 miles over common earth roads with a tank wagon instead of shipping by railway. In a number of cases examined by the author for the purpose of this record, the railroad rate is 14 to 15 cts. per ton-mile. Apparently, then, the Standard Oil Co. thinks it cheaper to deliver oil by wagon than to ship it by rail at 14 or 15 cts. per ton-mile. This is done when four and sometimes when six horses are required to haul a ton. In one sense the use of four or six horses to haul a ton makes the cost by wagon about twice or thrice that by rail. Why then does the Standard Oil Co. haul oil at an apparent loss? The answer is that the men are paid by the day and the horses must be fed whether they work or not, and therefore it is better for them to earn something than to remain idle. This is exactly the argument that the farmer makes in trying to show that as a rule it costs him little or nothing to market his crops. As evidence that the company knows what it is doing, it may be stated that all feed issued to the drivers is weighed, and if the amount or cost of feed per team differs materially from the standard adopted by the company the matter is carefully inquired into by the central office. The horses are weighed at stated intervals to see that they maintain their normal condition.

I close with an example of a slightly different phase of the subject. In discussions of this character, attempts are frequently made to determine the value per day of a team and driver. A few data on this subject will now be given.

1. Some years ago a millionaire purchased a thousand or more acres of land and started a scientific farm. Careful accounts were kept with the several departments of the farm work. The feed of a two-horse team was reckoned at 50 cts. per day and its labor at the same sum. A driver was assumed to cost $1 per day. At these prices the teams were in considerable demand and were freely hired out. Every department of the farm showed a profit, but the horse account was the most profitable. These teams were kept in condition and hauled 1½ tons 30 miles on an ordinary hard prairie road, for a day's work, including returning empty, which is equivalent to 13⅓ cts. per ton-mile.

2. The University of Illinois Agricultural Experiment Station in Bulletin No. 50 (1898) gives the data employed in trying to find the cost of raising corn. The data represents 316 replies to 1,000 circulars sent to all parts of the state of Illinois. The farmers were asked: "What is the rate of wages of man and team"? The average for each of 76 counties varies from $1.40 to $2.74, the average of all being $2.13. It should be remembered that the price returned was the value of the time employed in raising and gathering the corn, and is therefore more than at any other time of the year. It may be mentioned that according to this bulletin in hauling 311,000 bushels of corn, shelled and unshelled, the average load was 62 bushels. If it were all shelled this is equivalent to 1.74 tons and if it were all unshelled it is equivalent to at least 2.2 tons. Therefore these replies indicate that the average load of corn is somewhere from 1¾ to 2¼ tons, which is considerably more than is frequently claimed. It is also interesting to note that the average haul for this corn was 3.2 miles, which also is considerably less than has been claimed.

3. The author knows of an intelligent, enterprising, successful farmer who, when there is nothing for his teams to do at home, seeks an opportunity to haul grain for his neighbors at $1 per day.

CONCLUSION.—Of course, a single example of price is not conclusive as to cost, but a unanimity of several prices is fair evidence as to cost. The preceding data are presented with the belief that they are representative, and that they warrant the following onclusions:

1. The ordinary maximum cost to freighters on earth roads is not more than 25 cts. per ton-mile.

2. During the summer months, the cost to freighters on level loam roads is about 20 cts. per ton-mile.

3. With a little choice as to the time of doing the work, the cost to the farmer is not more than 10 or 12 cts. per ton-mile on earth roads, and when farm work is not pressing the cost is not more than 6 to 9 cts. per ton-mile.

4. The cost to farmers of hauling upon the best stone roads would not be much less than the cost upon earth roads when in their best condition, since the best earth roads are nearly as good as stone roads. Farther, the size of the load is limited by the capacity of the wagon, and in most localities the wagon is designed primarily for general farm work and moderately light loads on the roads, and therefore with hard roads the load could not be much increased without a change in the wagon, which will unfit it for general farm work.

5. The cost of hauling upon stone roads is much less than upon muddy earth roads, but most farm produce that goes to market in full loads can wait for a favorable condition of the earth road.

The final conclusion to be drawn from the preceding discussion is that the possible saving in the transportation of freight by wagons through road improvement will be an insignificant part of the cost of such improvement. This does not mean that the roads should not be improved; but it does mean that no great improvement can be justified alone on the ground of reducing the cost of transportation. Farmers are unanimously of the opinion that the cost to them of wagon transportation is a matter of small moment. It is believed that the preceding discussion shows that this opinion is correct; and it also shows why farmers have been so little influenced, at least favorably, by the arguments of road reformers who claim that the farmer is losing vast sums annually by not having permanently hard roads upon which to haul his products to market.

Good roads are desirable for the same reason that a man buys a carriage or builds a fine house, i. e., because they are a comfort and a pleasure; and not because they are financially profitable.

COST OF EARTH ROADS.

Statistics as to receipts and expenditures for road work were obtained from the townships of Champaign Co., Ill., the county containing about 1,000 sq. miles. There are 153 miles of railway. Farm lands, without buildings, sell from $80 to $100 per acre. Population, 47,000, of which 15,000 are in the adjoining cities of Champaign and Urbana. There are 1.97 miles of public rural highway per sq. mile of area, exclusive of streets and roads within incorporated cities or villages, and of the area of municipalities. In Illinois three forms of road taxes may be levied: (1) a poll tax, payable in labor or cash; (2) a district road tax, payable as above; (3) a road and bridge tax, payable in cash. In commuting the poll tax, a day's

labor is taken as $1; for the district tax, $1.25 for labor or $1.50 for a team and wagon or plow. A team, wagon and driver are then, in law, equivalent to $2.75 per day. The townships assess a poll tax of $1 to $2 per individual, but the exemptions are numerous and the collection is difficult, therefore the total receipts are small. This tax is equivalent to $2.49 per mile of road. Half of the 28 townships levy a district road tax, which is uniform over the township. This varies from 10 to 50 cts. per $100 of assessed valuation; the average being 25 cts. This is paid in labor, except by a few non-resident land owners. The average in the townships is $8.44 per mile, ranging from $3.51 to $13.83. As these two taxes are paid in labor, the total labor tax in half the townships averages $10.93 per mile, while in the other half it is $2.49.

The average levy of the road and bridge tax in the townships was 56 cts. per $100 of assessed valuation, ranging from 25 cts. to $1. The average taxes per mile are $23.93, the range being from $11.70 to $54.70. The total labor and cash tax in the county is $33.23 per mile, the range being from $16.60 to $52.70.

All the townships reporting spent money for new iron bridges, averaging $16.20 per mile in each township, the range being from $6.30 to $37.40. The county pays half of the total cost of the large bridges, but the above cost does not include this. In money spent for bridges, Champaign may be exceptional, as the county is comparatively flat and has probably fewer bridges than other parts of the state. On the other hand, it has numerous dredged ditches to be crossed and it is building first-class bridges, so that the county is probably spending more money for such work than other parts of the state.

Drainage cost $6.32 per mile for outlets through dredged ditches and for tile drains. About 75% of the townships spent an average of $1.32 per mile of road for tile culverts, and all the townships averaged $2.93 per mile of road for repairs to bridges and culverts. About 80% of the townships averaged $1.43 per mile for grading (not simply smoothing and leveling), while all the townships spent money for smoothing and leveling (not grading), this averaging $2.83 per mile, with a range of 40 cts. to $10 per mile. For mowing the roadsides, the average for 75% of the townships was $1.14 per mile. The total of the preceding expenses is $32.17 per mile of road, or $64 per sq. mile, or 10 cts. per acre.

The average expense is less than the total tax received, since the latter includes the expenses of administration, as to which no figures were obtained. The expenditures for new "iron" bridges, tile culverts and drainage amounted to $23.84 per mile, or nearly 75% of the total expense, and are for permanent improvements. This was done by contract. If grading is considered a permanent improvement, it brings the total up to $25.27 per mile. Repairs of bridges and culverts, smoothing the roads and mowing the roadsides are expenses of maintenance, representing a total of $6.90 per mile. The following conclusions are presented:

1. Almost 75% of the expenditures were for contract work, to which the criticisms against the labor system do not apply.

2. The expenditures for maintenance proper is so small as to make it impracticable to delegate this work to one or more who shall give their whole time to the work. Without some such division of labor, it is highly improbable that our roads will reach a very high state of maintenance.

3. The expenditures for permanent improvements are needed for present conditions, and would be absolutely necessary before hard roads could be introduced.

4. Until farmers are willing to tax themselves more than $32 per annum per mile for earth roads, it is needless to expect them to willingly pay for hard roads. Further, until they wear more expensive clothing and live in finer houses it is unreasonable to expect them to willingly support the most luxurious public highways.

REPORT OF THE ANNUAL MEETING OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.

The sixteenth annual meeting of the society was held at Bloomington, Ill., Jan. 23, 24 and 25, the sessions being held in the Council Chamber of the City Hall. Between 40 and 50 members were present. The meeting was exceptionally interesting and successful, and a large number of good papers were read and well discussed. The only drawback was the lack of hotel facilities, owing to the severe fire which destroyed a large part of the business section of the city last summer. The capacity of the existing accommodations was so overstrained that certain prominent engineers were provided with quarters at the jail, by the courtesy (not the commands) of the sheriff.

WEDNESDAY PROCEEDINGS; JAN. 23.

At 2:30 p. m. the meeting was called to order by the President, Mr. C. C. Brown, of Bloomington, about 25 members being present. An address of welcome was delivered by the Mayor, Mr. L. B. Thomas, who referred to the work of the civil engineer in improving streets and roads, and in providing sewerage systems by which the sanitary conditions of cities and towns are improved. This address was responded to by the Vice-President, Mr. H. C. Paddock (City Engineer of Moline), who spoke of the engineering works in and around Bloomington, and of the energetic action of the city in rebuilding after the great fire of last summer. In general, he thought that sewage disposal and garbage disposal were among the great problems now confronting the engineer. In the annual address, Mr. Brown referred to the status of the road improvement problem (particularly in regard to its economic aspects), to the work of eliminating grade crossings in the state; to the proposed topographical survey of Illinois, and also to the proposition for a state law requiring engineers and surveyors to pass examinations and secure licenses, as is now required for architects.

After a short discussion on the topical question, "What Legislation is Needed to Secure Legal Reports from all Drainage and Levee Districts," a paper on "Open Water Course Drains for Land Drainage" was read by Mr. P. C. Knight, of Pontiac. He referred to the need of more definite knowledge as to the basis on which formulas for such open drains or ditches are established, and to the value of marsh land after drainage, this drainage being usually effected by open channels.

A paper on "A Proposed Topographical Map of Illinois" was then read by Mr. W. H. Herron (U. S. Geological Survey). It is proposed to have a survey and map made through the joint action of the U. S. Geological Survey and the state authorities, as has been in New York, New Jersey and Massachusetts. The cost to the state is estimated at $8 per sq. mile. Such maps are of great assistance in connection with projects for water supply, water power, sewerage, sewage disposal, roads and railways, etc., but Mr. Ketchum (University of Illinois), doubted if the map proposed at a cost of $8 per sq. mile would be sufficiently in detail. If the work is to be done it might warrant an expenditure of even $16 per sq. mile. He referred to a map prepared in 1892 for the Columbian Exhibition. Mr. W. H. Hay (County Surveyor, of Sandwich), stated that this was made by aneroid barometers, lines being run between railway stations whose profile elevations had been reduced to a sea-level datum. This might have been accurate if two barometers had been used, one (self-recording) being left at the starting point as a check upon the readings of the one carried over the line. The appropriation would not admit of this, however, and as barometers are subject to frequent fluctuations (sudden or gradual according to meteorological conditions) it was impossible to know when and how much the readings varied. In consequence the map made was merely an approximation.

In a short discussion on the topical subject of "Advantages and Values of Fillers for Brick Pavements," Prof. I. O. Baker (University of Illinois) stated that sand filling did not support the bricks at the edges, which are thus liable to chip. Cement grout or tar filling are much to be preferred, even at their higher cost. Mr. H. E. Beasley (City Engineer of Peoria) also showed that street sweepers were responsible for sucking the sand out of the joints.

At the evening session, Mr. W. H. Tarrant, City Engineer of Champaign, presented the report of the Committee on Roads and Pavements:

In the past year, few counties in the state have constructed permanent hard roads. Meetings have been held throughout the state to discuss the road question, and at all these meetings there was a lack of knowledge of the means and methods of securing good roads. The most serious problem as to hard roads is finding the material with which to construct them. In each township the highway commissioners levy each year an average of 30 cts. per $100 of assessed valuation. Half of this is expended on permanent bridges. Brick pavements have to a large extent been constructed in the larger cities.

Many of the small cities in the state have no pavements, and it is now difficult for them to make a beginning. The Board of Local Improvements Act, passed in 1899, provides that in cities of less than 10,000 no ordinance for improvements shall be adopted unless a majority of the resident property owners affected shall petition for the same. This practically blocks all sewer and drainage work, and the restriction should be repealed.

Two papers on the road question were read by Prof. I. O. Baker, and abstracts of these are published in this issue. They were on "The Cost of Wagon Transportation" and "The Cost of Earth Roads." Mr. Baker put the average cost at about 20 cts. per ton-mile for transportation, but Mr. H. H. Gross, representing the Road Enquiry Office of the U. S. Department of Agriculture put it at 50 to 60 cts., as an average of the state. Very few members advocated state aid in road work, but one member thought that the poorer counties should be assisted in the interests of the community. Mr. Burnham disputed the idea that a labor tax is entirely inefficient and wasteful. Prof. Baker pointed out that more attention should be paid to drainage and ditches, and to maintaining a smooth and uniform slope from the center to the side ditches. On dirt roads, a light harrow may be used to level off ridges and fill the ruts. Mr. E. E. R. Tratman, of the editorial staff of Engineering News, referred to the general neglect of the question of maintenance in discussions on good roads. A good road will deteriorate without such maintenance, and many of the present roads could be made really good roads by systematic inspection. He referred to the gravel and dirt roads of Du Page county, and to the practice of "repairing" roads by dumping a wagon load of gravel in one spot, leaving a ridge some 2 ft. high for traffic to pass over. The last paper of the evening was on "The Hard Roads of McLean County," by Mr. A. H. Bell. The road discussion lasted until a late hour, the session adjourning at 11 p. m.

THURSDAY PROCEEDINGS; JAN. 24.

The meeting opened about 9 a. m., and Mr. W. H. Tarrant, City Engineer of Champaign, read a paper on "Modern Brick Pavements," an abstract of which we shall give in another issue. Prof. Baker then presented the report of the special committee appointed to consider the proposed co-operation of the state authorities with the U. S. Geological Survey for a topographical map of the state. It was recommended that the survey should expend an amount equal to that of the state, the latter and 60% of the former to be expended for the subsistence of field parties and for the services of temporary employees resident in the state. The society should petition the state legislature to make an appropriation of $20,000 per annum for the purpose. This matter was referred to a committee of five members.

Mr. S. A. Bullard then read the report of the Committee on Architecture, in which the satisfactory results of the state law providing for the licensing of architects were set forth, and showing that the law was devised for the benefit of the public and only incidentally for that of the architect. It was also stated that a law has been passed to create the position of State Architect, but this is unsatisfactory from the fact of its being largely a political measure, and radical amendment was recommended. Prof. Baker introduced Mr. Geo. H. Frost, the founder of Engineering News, and who was largely instrumental in the successful organization of the society 16 years ago. Mr. Frost was elected an Honorary Member, and acknowledged the honor in a few appropriate remarks.

A resolution introduced by Mr. Jacob A. Harman (of Peoria), on the "good roads" question, was adopted. This recommended that the state should assume and pay, by general taxation, a fair proportion of the cost of road improvement, provided that a suitable plan should be devised for distributing the cost between the state, county, township and contiguous property benefited, and also provided that the initiation of each improvement should rest with the people of the locality. It further required that the maintenance of the roads should be carefully provided for. Prof. A. N. Talbot (University of Illinois) then read the report of the Committee on Paving Brick Specifications and Tests. He reviewed the new standard tests adopted by the National Brickmakers' Association, and suggested that the society should recommend to engineers the use of the standard methods of tests given in the report. Mr. D. W. Mead (of Chicago) thought the requirements of the tests were too high to be practicable, and that it would be better to make lower requirements and have them strictly enforced. The recommendations of the committee were adopted. The standard method of conducting the rattler test, as given in the report, is as follows:

RATTLER TEST FOR PAVING BRICK.

1. Standard Rattler.—The standard rattler shall be polygonal in cross-section, with 14 plane staves, spaced ¼-in. apart at their edges, and the interior shall be free from projections, offsets, roughnesses or obstructions. Rattlers having two staves more or less than the standard number may be used. The internal dimensions shall be 28 ins. in diameter and 20 ins. in length.

2. Standard Shot.—A mixture of two sizes of shot will be used. The larger size will be about 2⅛ ins. square and 4½ ins. long and will weigh about 7⅛ lbs. The smaller size will be 1½ ins. in each direction and will weigh about ⅞-lb. The shot shall be made of ordinary machinery cast iron, and all edges shall be made rounded to a radius of about ¼-in. The individual shot shall be replaced by new pieces whenever they have lost 1% of their original weight. For the standard size of rattler the standard charge of shot shall consist of 75 lbs. of large shot and 225 lbs. of small shot.

3. Number and Condition of Brick.—For the standard size of rattler, 12 paving bricks or 9 paving blocks will constitute the number to be used in a single test, but two more or less than this number may be used. The bricks shall be thoroughly dried before testing.

4. The Test.—The rattler shall be rotated at a rate of not less than 28 nor more than 30 revolutions per minute, and 1,800 revolutions shall constitute the standard test. The speed requirement is important.

5. The Results.—The loss shall be calculated in percentages of the original weight of the dry brick composing the charge. In weighing the rattled brick, any piece weighing less than ½-lb. shall be rejected.

6. Variations in Size of Rattler.—Rattlers 28 ins. in diameter and of a length greater than 20 ins. may be used, in which case the charge of shot and the number of brick shall be increased proportionally to the increase of length. Rattlers of smaller diameter will give smaller losses, which cannot accurately be compared with those obtained with the 28-in. diameter. However, if 24-in. or 26-in. rattlers are used, it is recommended that the charge of cast-iron shot be equal in volume to 10% of the volume of the rattler, which is about 1 lb. of shot to each 40 cu. ins. of rattler volume. For a 24-in. machine the charge should be composed of half large size and half small size of shot, and for the 26-in. machine one-third large size and two-thirds small size.

The question as to what maximum allowance should be made for errors in alinement and bearing, in adopting old corners not made by the government surveyor, was briefly discussed by Mr. J. L. Clark (of Momence), Mr. H. G. Paddock (of Moline), and Mr. M. S. Ketchum. The opinion seemed to be that this should be considered in regard to what would be best for the property, rather than to define any maximum lineal error. Prof. N. Clifford Ricker, Professor of Architecture at the University of Illinois, then read a paper on "The Results of the License Law

for Architects in Illinois." This is an important matter, and as the present law is the basis for the proposed license law for land surveyors, we shall give an abstract of this paper. The meeting then adjourned.

In the afternoon there was an excursion in a special car provided by the Bloomington & Normal Electric Ry. Co. The city water-works and electric light plant was first visited, where the air-lift system is in use to supplement the supply of the main well. The party then proceeded to the shops of the Chicago & Alton Ry., and inspected the improvements and extension now in progress, all of which were explained by Mr. C. M. Mendenhall, Superintendent of Motive Power, who took charge of the party. After a trip over a hard road which is covered with clay deposited by the wheels of wagons coming from a dirt road, the party proceeded to the electric lighting and steam heating company's plant, which operates a Yaryan hot-water distribution system. The party also looked over the building now being erected for a steam distribution system.

At the evening meeting, officers were elected as follows: President, H. G. Paddock, City Engineer of Moline; Vice-President, Emil Rudolph, of Chicago; Trustees, P. C. Knight, of Pontiac, and J. G. Mellulsh, of Bloomington. The city of Joliet was selected for the annual meeting of 1902.

The report of the Committee on Railways was then presented by the chairman, E. E. Russell Tratman, of Engineering News. This showed an increase of 103 miles of line and 388 miles of track for steam railways; and 20 miles of line and 53 miles of track for electric, elevated and surface railways. Particulars were given of the extensive works for permanent improvements which have been carried out by railways in Illinois during the past year, and one section of the report was devoted to the question of long distance electric railways. A paper by Mr. W. H. Rosencrans (of Chicago) was then read, an abstract of which is given below.

STREET RAILWAY SUBWAY SYSTEM FOR CHICAGO.

The city of Chicago is in great need of relief for the present congested condition of traffic in the downtown district. The elevated railways, with their downtown loop, were expected to relieve this district in a measure, but while they do an enormous business the surface lines seem to be fully as busy as before the elevated loop went into operation.

The most practical solution, and the one which will furnish the most lasting benefits is a system of subways to eliminate all surface lines north of 12th St., and east of the river. With this should go asphalt paving for the streets, the widening of the sidewalks, and the placing of all electric wires, gas and water mains and sewers in this subway, when the necessity arises to rebuild them.

A deep level subway seems to be the most practical, doing all the work of construction by modern engineering methods of tunneling, the city openings to the surface of the streets being at shafts, tunnel ends and the larger station locations. By this method the business contained within the district traversed by the subway system (which is probably greater than any other like territory in any other city in this country) need not be seriously interfered with. The present systems of sewers, gas mains, water mains and electric wires need be but little interfered with until the completion of the subway, in which provision will be made for taking care of all these mains and wires. The removal of the material excavated to the wharves and railways can be done in the line of the completed tunnel without interfering with surface traffic in the least.

The minimum depth of the upper arch of the tunnel below the street surface would be about 16 ft. The average depth of sewers in the business district is about 12 ft. All other pipes and wires are of course nearer the surface. The depth of the invert of a tunnel 28-ft. diameter would be 44 ft. The material is clay, which, while it stands in a firm bank, yields readily to the pick and shovel.

The Hastings tunneling shield which was used in the 25-ft. sewer tunnel on 39th St., would work even better here.

The proposed route would afford ample facilities for accommodating the surface street-car lines which converge from the North, the West and the South. Double tracks should be laid on each line and the necessary switches, crossovers, etc., placed as required to accommodate the different interests. The scheme contemplates an outer loop traversing State St., Randolph St., Franklin St., and Jackson Boulevard. Two arteries enter from the West on Washington St. and Van Buren St.; two on the North, by La Salle St. and the proposed Park subway; and two on the South, by State St. and Clark St. Cross intersecting lines within the outer loop should be built on Washington, Madison, Monroe and Adams Sts. This would complete the system and provide ample room and facilities for handling the heaviest traffic in the most expeditious way possible. Under favorable conditions, each terminal line could be dug at the rate of one foot an hour or 24 ft. in a day working three shifts of eight hours each. The construction of walls and completion of the lining of the tunnel must keep pace with the digging. At this rate, 72 ft of completed main line of tunnel would be made each day.

Stations should be located within buildings adjacent to the line where possible, and at points where this is impossible the openings should be on the sidewalk. The total climb from the floor of the car to the surface of the street would be about 32 ft., or not more than most of the elevated railway stations require.

The tunnel walls should be built of concrete, on an improved plan. The inner wall should be 12 ins. thick and plastered against the outer wall.

Mr. B. J. Ashley (of Chicago) then read a paper describing the engineering practice employed in designing Zion City, Ill., and in making a topographical survey of the site. The design of this city has been described in our columns. A draft of the proposed bill for the licensing of land surveyors was read by Mr. J. G. Mellulsh. This is based upon similar bills previously proposed and upon the existing law for the licensing of architects. The last paper of the evening was by Mr. Jacob A. Harman, of Peoria, on "Progress in Invention in the 19th Century," reviewing the wonderful progress made and the almost innumerable inventions of world-wide importance. During the first 75 years of the century, the U. S. Patent Office granted about 150,000 patents, while in the last 25 years it granted about 500,000 patents. The meeting adjourned about 11 p. m.

FRIDAY PROCEEDINGS; JAN. 25.

At the first proceeding, Mr. D. W. Mead, of the Committee on Sanitary Legislation, suggested that this committee should be discontinued. He urged members to write to their representatives in the legislature and do all in their power to forward the bills for making a topographical survey of the state, and for licensing land surveyors in the state. Mr. A. L. Kuehn (University of Illinois) read a paper on "The Calculation and Staking Out of Railway Earthwork." The report of the Executive Board recommended that the special committees on mechanical engineering, electrical engineering and architecture should be made standing committees. It also recommended that the salary of the secretary be increased to $150 per year. The report of Mr. M. S. Ketchum, Secretary and Treasurer, showed the following particulars of the standing of the society: Receipts for 1900, $756; expenditures, $722; balance (cash), $34. There are now 101 members.

Two papers on railway subjects were then read, as follows: "The Construction of the Indiana, Illinois & Iowa R. R.," by Mr. O. C. Whitsell, Engineer of Construction (of Streator); and "The Copper Range R. R., by Mr. C. C. Stowell (of Rockford). The Committee on Press presented its report through Mr. E. E. Russell Tratman, and the report of the Committee on Mechanical Engineering, prepared by Mr. E. E. Johnson (Chicago), was read by Mr. D. W. Mead. This report dealt with the marvelous development in the production of power, its utilization and its transmission. A resolution of thanks to the local members, clubs, companies, etc., who had aided in entertaining the society, was then adopted, and brief remarks were made by the outgoing and incoming officers. The last proceeding was the announcement of Mr. A. L. Kuehn, of Champaign, as Secretary. The meeting then adjourned.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

The seventh annual meeting of this society was held at the rooms of the American Society of Mechanical Engineers on Jan. 22, 23 and 24. The first session, on Tuesday afternoon, was devoted to general business and reports of officers and committees. The Committee on Legislation reported that progress was being made in the direction of legislation in regard to the ventilation of schools and other public buildings, and that bills on the subject had been introduced in the legislatures of New York, Pennsylvania and New Jersey. The Committee on Standards reported a code for testing the efficiency of heating plants at temperatures above 0° F. The report was ordered printed for distribution, and the committee instructed to bring in a revised report at the next annual meeting. The committee on conference with the architects' society relating to fees for engineering services rendered to architects reported satisfactory progress, and it was continued.

At the evening session a paper by Mr. Reginald Pelham Bolton on "The Elements of Time in Contracts" was read and discussed. The following is a brief abstract of the paper:

Vexation and uncertainty surround this simple phrase to the engineering contractor. It is the one indefinite item in his estimates, the only unformulated feature in his studies, and yet the essential and fruitful cause of difficulty in his business. It remains, however, the fact that all forms of construction involving the use of metals, are especially liable to delays, due to the nature of the materials dealt with, the variety of operations necessary to their formation into a completed shape, and, where erected as part of a building, or other structure, to peculiar hindrances and delays of other parts of the construction, often to an extraordinary and quite unexpected extent, all of which are frequently inevitable.

The law upon the subject is in all countries as uncertain of application as the subject itself, and the legal faculty seems to have no definite or substantial grasp of the special difficulties of engineering construction, for the most part interpreting the law by that jack-in-the-box known as "trade usage," which is almost always sprung by one side or the other upon an unhappy and untechnical court.

The whip-lash of consequential damages, which is so often held over the head of the delinquent contractor and manufacturer, is perhaps more of a bugbear than a reality, nevertheless it is notorious that numerous cases of unjust penalties have been inflicted, not only by sympathetically-inclined juries, but by lenient arbitrators and judges.

It is well known that the law is thus misused for mean and dishonest attempts, and that its delays and ruinous cost are utilized as a means of unfair pressure in order to elicit concessions.

A contract containing, as most steam-heating contracts do, a rigidly fixed date by which the work must be completed, should only be accepted with the condition that all other work shall be advanced proportionately and regularly. It is now frequently demanded that the contractor shall provide overtime and night work if required to complete his entire work by the due date. The judgment of some experienced and technical person should be required as a referee to decide on the spot when such work is necessary or whether it has been caused by the delay of the contractor or of others. The provisions of the "Uniform Contract" in this respect are one-sided and unsatisfactory.

A discussion was then held on the subject, "Methods of Ventilating Office Buildings." At the third session, on Wednesday afternoon, two papers were read and discussed. The first was a brief one by John Gormly, entitled "A Low-Pressure Hot Water System Receiving Heat from a Steam Boiler." It described a small plant in which a steam coil taking steam from a boiler was used to heat the water circulated in the heating system. It was found to work much better when the coil was supplied with hot water from the boiler than when it was supplied with steam. The second paper, by Wm. H. Bryan, was entitled "Central Station Heating." An abstract of this paper will be given in another issue.

On Wednesday evening a dinner was held at the Arena."

At the session on Thursday morning a paper on the "Theory of Low Pressure Steam Heating," by G. Dessoison, of Paris, was read and discussed. This was a very elaborate paper, fully illustrated, describing the French system of steam-heating. It differs radically from the American system, especially in supplying to each radiator only the amount of steam it can condense, the supply being regulated by nicely adjusted automatic valves. The author claimed that it avoided the alleged defects and troubles of the American system, but in the discussion this statement was combatted, and it was held that the American system was vastly superior to the French. At the afternoon session a paper was read by Prof. R. C. Carpenter on a combined system of hot-air and steam heating. It was shown that it was very difficult to make the combined system work properly, and it was condemned on that account. Discussions of topical questions, and of the report of the committee on standards occupied the remainder of the session.

The society is steadily increasing in strength and influence, and its finances are in a sound condition. The membership increased slightly during the year, but large accessions are expected in the ensuing year. It was decided to hold a midsummer meeting in Chicago. The following officers were elected for the ensuing year: President, Prof. J. H. Kinealy, St. Louis; First Vice-President, A. H. Kenrick, Boston; Second Vice-President, A. Harvey, Detroit; Secretary, Wm. M. Mackay, New York; Treasurer, J. A. Goodrich, New York; Governors, Prof. R. C. Carpenter, Ithaca; John Gormley, Philadelphia; C. B. J. Snyder and Wm. Kent, New York.

THE SHERMAN TUNNEL of the Union Pacific R. R. is nearing completion. This tunnel is 39 miles west of Cheyenne, Wyo.; it is 1,800 ft. long, and is being built by Kilpatrick Bros. & Collins, of Lincoln, Neb., and McArthur Bros., of Chicago. The improvement, however, includes besides the tunnel the grading of 40 miles of line and the building of a bridge over Dale Creek. Work was commenced in April, 1900, and it is to be finished in three years from that date at an estimated cost of $2,500,000. The object of the improvement is to eliminate the grades of 85 to 115 ft. per mile now required to cross the mountain, and to reduce them to the maximum of 43 ft. per mile now adopted on the Union Pacific system.

ENGLISH TRADE UNIONS, of which we hear so much complaint from English manufacturers, are reported upon by the British Board of Trade. There were in England 1,292 unions, with 1,802,518 members at the end of 1899; an increase of 20% in membership in eight years. Figures upon the income, expenditures, etc., of 100 of the principal unions with 1,117,465 members, show that at the end of 1899 they had in their treasury $15,976,640. The total annual income was $9,060,185. The decrease in expenditure in the metal, engineering and shipbuilding trades amounted to $917,880, as compared with 1898; the expenditures for these two years being, respectively, $2,234,439 and $3,054,989.

A JAPANESE TROLLEY RAILWAY has been constructed between Tokio and Yumoto, in the neighboring hills and lying at an altitude of 426 ft. above the sea. The line is 8 miles long, has a single track with numerous turnouts and is operated on the overhead trolley system. The cars are long and are mounted on two 4-wheeled trucks. The power is obtained from a water-fall at Haya Kawa. It is proposed to extend the line to Miyanoshta, lying 1,410 ft. above the sea, and a sanitarium is to be established there.

THE FOREIGN COMMERCE OF THE UNITED States has been analyzed by the U. S. Bureau of Statistics, for the period 1890-1900. The prominent features in this analysis are the remarkable increase in the importation of manufacturers' materials and an even greater increase in the exportation of manufactured goods. Tabulated, the record stands as follows, in percentages of total imports and exports and in values of the same:

	1890.	1900.
Food stuffs and live animals, imports	31.5	26.4
Manufactures and luxuries, imports	34.6	29.5
Manufactured materials, imports	34.3	44.0
Agricultural products, exports	74.3	62.2
Manufactures, exports	18.5	30.4

	Values. 1890.	1900.
Manufacturers' materials, import	$282,839,094	$365,144,600
Manufactures, export	157,126,803	441,406,942
Food stuff and live animals, import	259,820,704	219,329,205
Agricultural products, export	628,779,597	904,658,958